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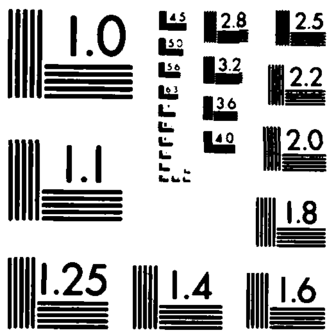

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TECHNICAL REPORT ATC-86-4

RED RIVER U-FRAME LOCK STRUCTURE ANALYSES COMPARISON

by

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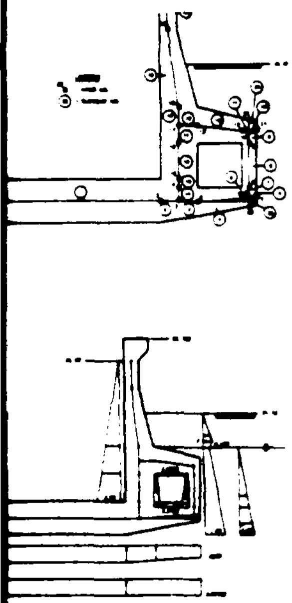

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents a comparative investigation involving the results of the structural analyses of a simplified frame model with beam elements and a detailed plane-strain finite-element model of a U-frame lock on the Red River. The GTSTRUDL computer program was utilized for this investigation. The study was scheduled on request of the US Army Engineer District, Vicksburg, and the structural dimensions and various loading cases were provided by this

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20. ABSTRACT (Continued).

Corps office. To aid with the study, the District made available the program runs of the planar rigid frame model of the U-frame for these load cases.

These comparisons reveal the points in each analysis that have not been considered, those that are and are not in agreement, those that may not be justified, and facts that do not appear to be correct.

The importance of further investigations involving analysis of the linearly elastic U-frame structure on elastic foundation has stemmed from this study. Research into elasto-plastic foundation and dynamic soil-structure interaction effects are other related areas open for the authors' expertise.

PREFACE

This report presents a comparative investigation of a U-frame structure using the results of a planar rigid-frame analysis and a detailed plane-strain finite-element model. The U-frame structure used for this comparison is Lock No. 3 on the Red River, presently being designed by the US Army Engineer District, Vicksburg. The structural analysis package GTSTRUDL was used to perform the finite-element analysis and the initial frame analysis. The program CUFRAM, developed by Dr. William Dawkins under the Computer-Aided Structural Engineering (CASE) project, was used to provide a further comparison. The structural dimensions and load cases were provided by the US Army Engineer District, Vicksburg.

The planar rigid-frame analysis using GTSTRUDL was performed by structural engineers at the Vicksburg District. The finite-element grid used in this study was prepared by Messrs. Kevin Abraham and Chris Merrill, Computer-Aided Design (CAD) group, Automation Technology Center (ATC), US Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss. Moment and shear calculations were performed by Mr. Abraham using the computer program CSMT. The finite-element run was accomplished and the initial report was prepared by Sankar C. Das, Associate Professor of Civil Engineering, Tulane University. The report was revised by Dr. Robert L. Hall, formerly with the Research Group, Scientific and Engineering Applications Division (SEAD), ATC, WES, under the general supervision of Mr. P. K. Senter, Chief, SEAD, ATC, WES. Dr. Hall managed and coordinated the work with Mr. C. C. Hamby being the point of contact with the Vicksburg District. Working closely with Dr. Hall during the period of report preparation and publication were Mses. Gilda Shurden and Frances Williams, editor and editorial assistant, Publications and Graphic Arts Division, WES. Dr. N. Radhakrishnan was Chief of the ATC, WES.

COL Allen F. Grum, USA, and Dr. Robert W. Whalin were Director and Technical Director, respectively, of WES during the finalization and publication of this technical report.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
feet	0.3048	metres
inches	2.54	centimetres
kips	4.448222	kilonewtons
kip-feet	138.255	kip-newtons
kips per square foot	47.88026	kilopascals
pounds per cubic foot	16.01846	kilograms per cubic metre
pounds per square foot	4.882428	kilograms per square metre

RED RIVER U-FRAME LOCK STRUCTURE ANALYSES COMPARISON

PART I: INTRODUCTION

1. Plans are underway for the Red River Lock, a reinforced concrete U-frame structure, to be located about 150 miles north of Baton Rouge. Contrary to the conventional lock, the U-frame lock is constructed as a monolithic unit, and may be founded directly on the subsoil without piles. The structure will be a reinforced concrete U-frame having a useable chamber, 84 by 685 ft,* with a wall height of 59 ft, and a base slab, 12 ft thick. The half section of the would-be structure is shown in Figure 1.

Purpose

2. The purpose of this investigation is to compare the results of the structural analysis of the simplified frame model involving beam elements with that of the detailed plane-strain finite-element model (FEM) of the U-frame using GTSTRUDL computer program. The US Army Engineer District, Vicksburg, requested this study and has provided the structural dimensions, various loading cases involving base soil-pressure, side soil-pressure, and water-pressure diagrams. The District has also made available the GTSTRUDL computer program runs of the planar rigid frame model of the U-frame for the various load cases.

Simplified Frame Model

3. The simplified mathematical model of the Red River U-frame involving beam elements and a few rigid links has been furnished by the Vicksburg District and is shown as the half section in Figure 2. The model involves 24 nodal points and 24 members. Members 1 through 22 are beam elements; members 23 and 24 are rigid links (Gamble 1977). Three different combinations for load conditions have been included in this study:

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* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

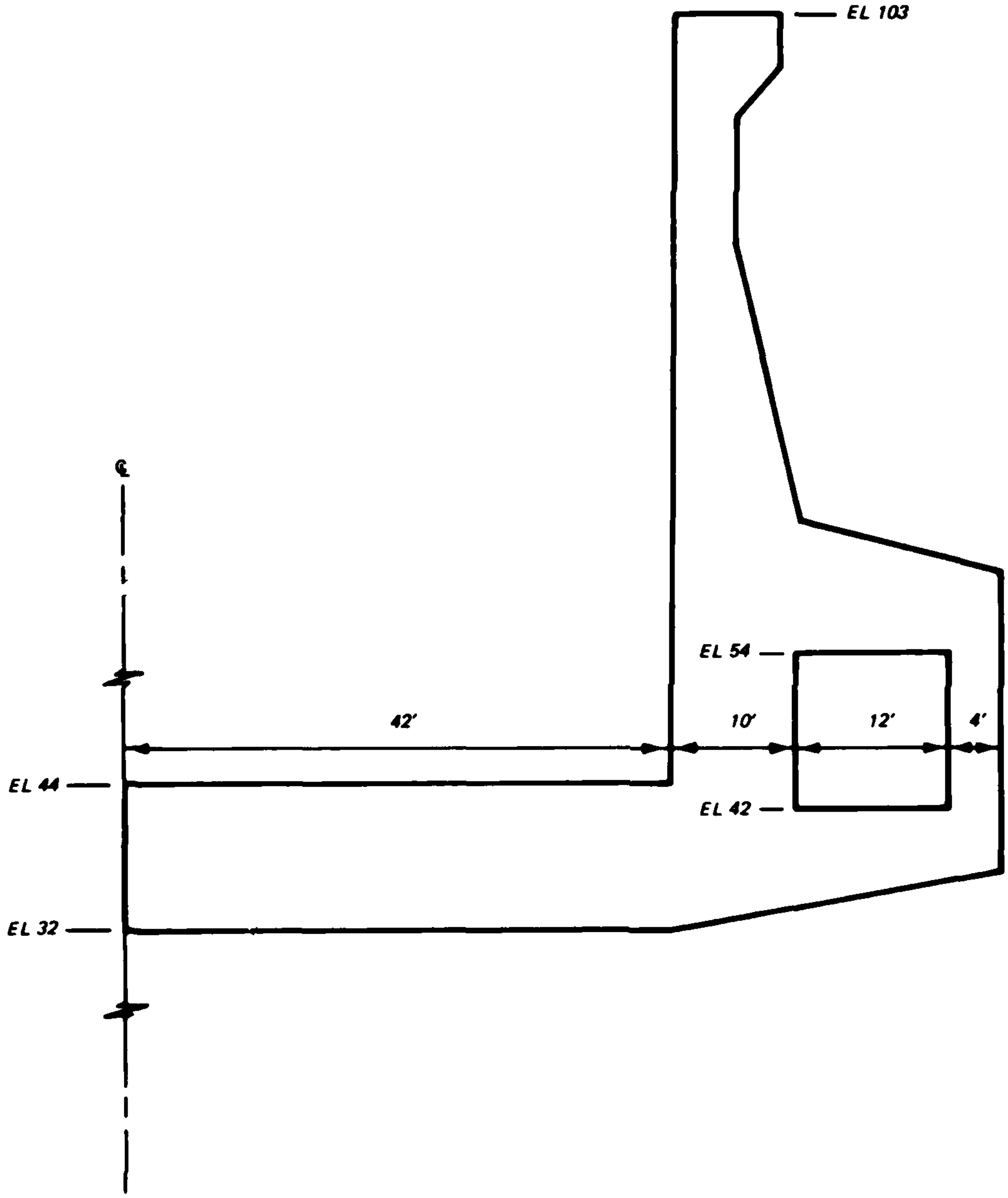

Figure 1. Half section of Red River U-frame

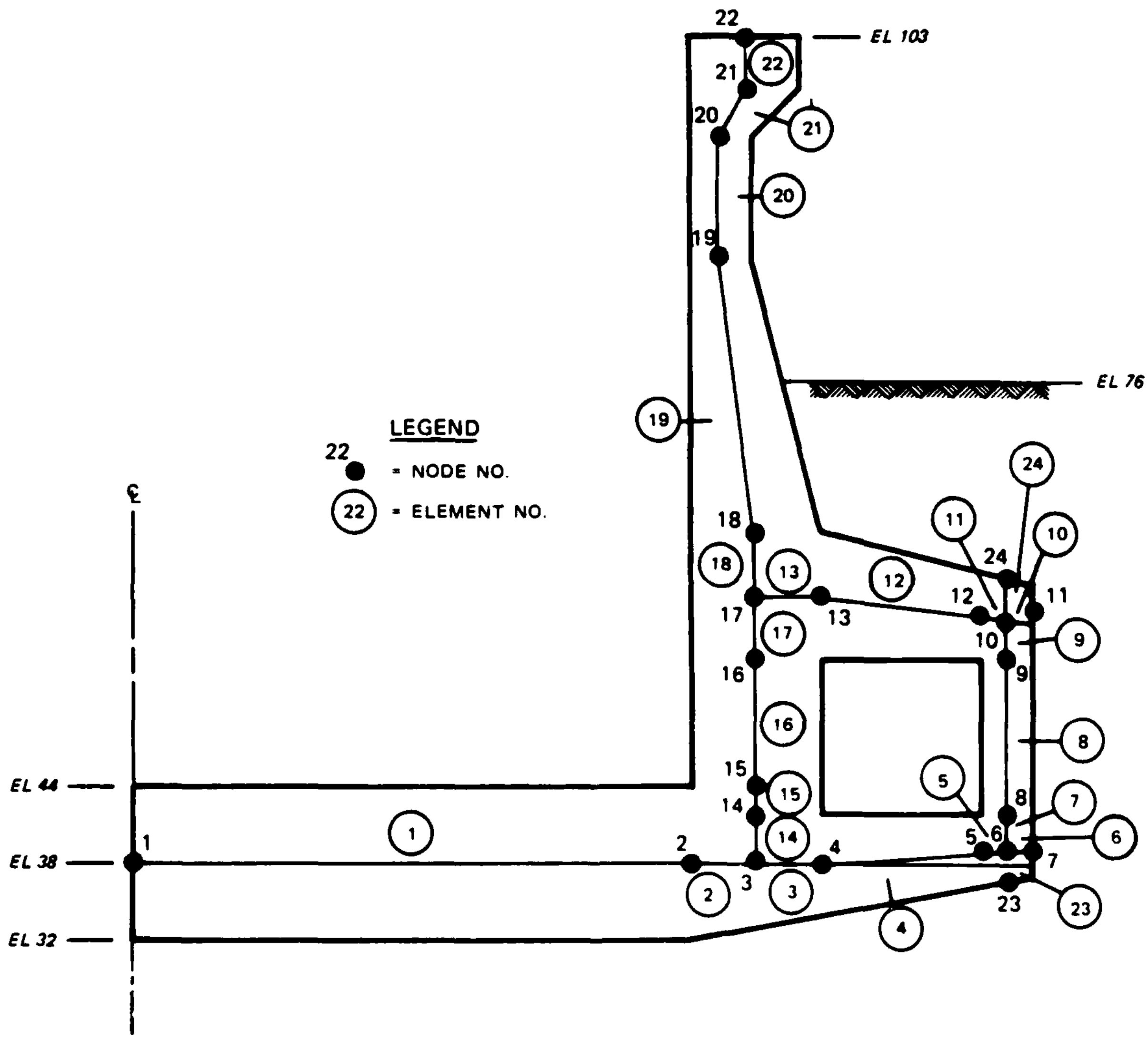

Figure 2. Simplified frame model of the half section for the U-frame

a. Construction with backfill conditions--Case 1B.

b. Normal operating condition--Case 2B.

c. Extreme maintenance condition--Case 5A.

4. The vertical base soil-pressure, horizontal side soil-pressure, and water-pressure diagrams for the above load cases are shown in Figures 3 through 5. The unit weight of water, compacted soil, and concrete used are 62.4 pcf, 130 pcf, and 150 pcf, respectively. The Young's Modulus of concrete used is 3.51 × 10 psi.

5. The planar rigid-frame analyses using beam-column elements were completed by the US Army Engineer District, Vicksburg. The analyses provided nodal-point displacements, axial and shear forces, and bending moments at each member joint for the three load combinations. These analyses were performed using GTSTRUDL.

Detailed Plane-Strain Finite-Element Model

6. The detailed finite-element mathematical model of the Red River U-frame involving plane-strain isoparametric elements has been developed at the US Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., and is shown in Figure 6. The model uses 974 nodal points and 280 plane-strain isoparametric quadratic quadrilateral (IPQQ) elements (Georgia Institute of Technology 1983). The Young's Modulus of Concrete and Poisson's ratio used are 3.51 × 10 psi a.. 0.2, respectively. Three computer runs for this plane-strain FEM were performed for the three different load cases as shown in Figures 3 through 5. At present, GTSTRUDL does not have the capability to apply the edge pressure on the IPQQ elements in the global projected direction. Because of this deficiency all the vertical base pressures, due to soil and water on the inclined surfaces, were transformed from a global direction into a local coordinate direction.

Analyses Performed by GTSTRUDL

7. The complete analyses, involving nodal-point displacements; stress components, σx , σy , and τxy , for the various elements at the nodal points for the three different load cases as mentioned before, have been performed using GTSTRUDL computer program. The above stress components at the

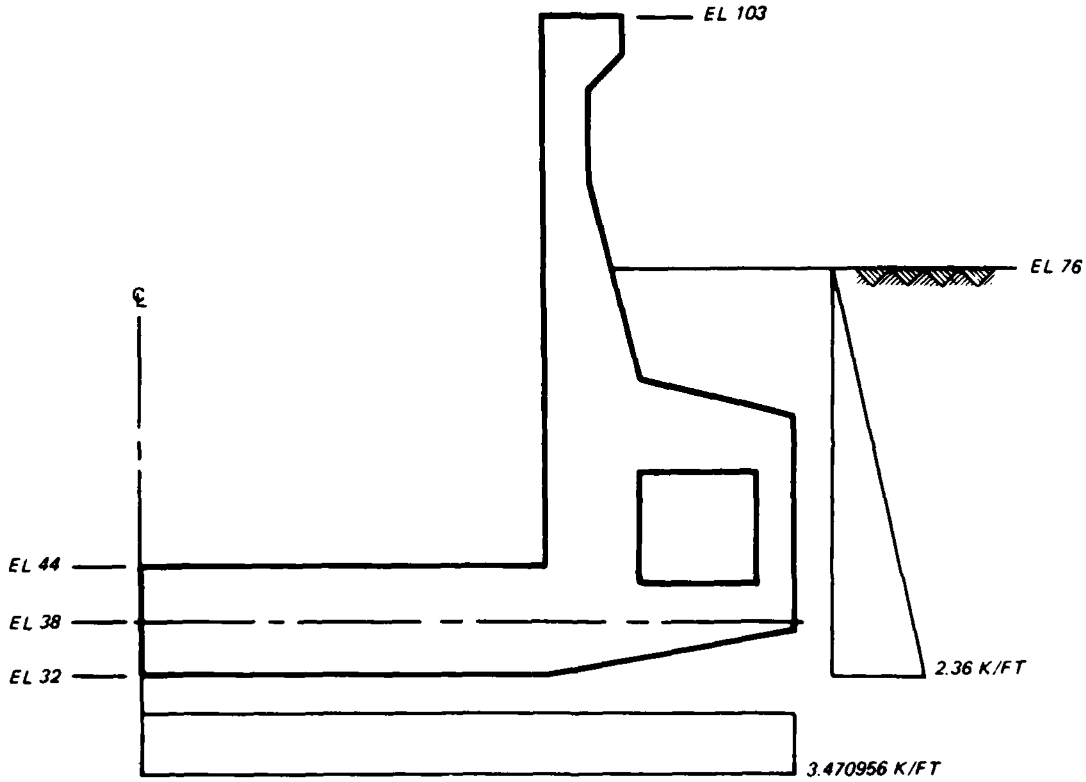

Figure 3. Load case 1B (without earthquake)--construction with backfill

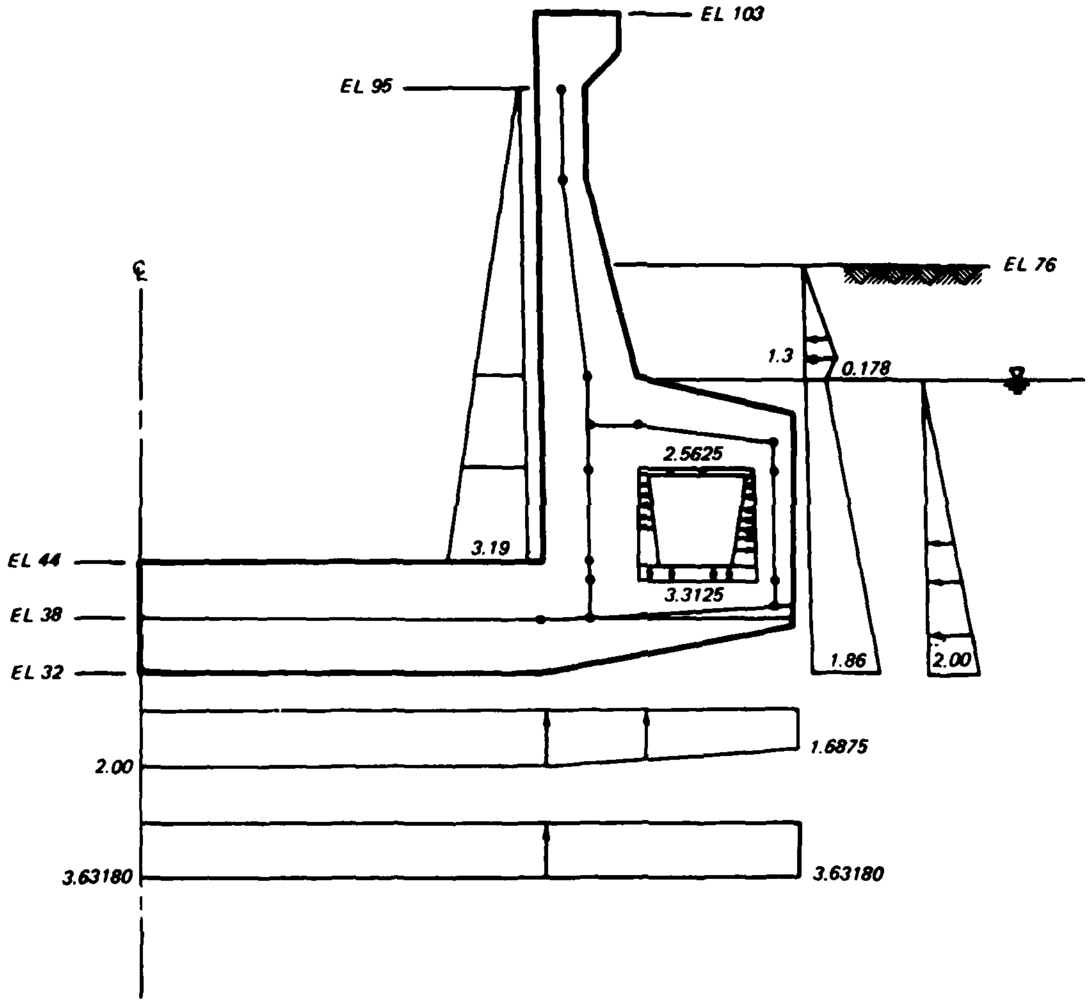

Figure 4. Load case 2B--normal operating condition

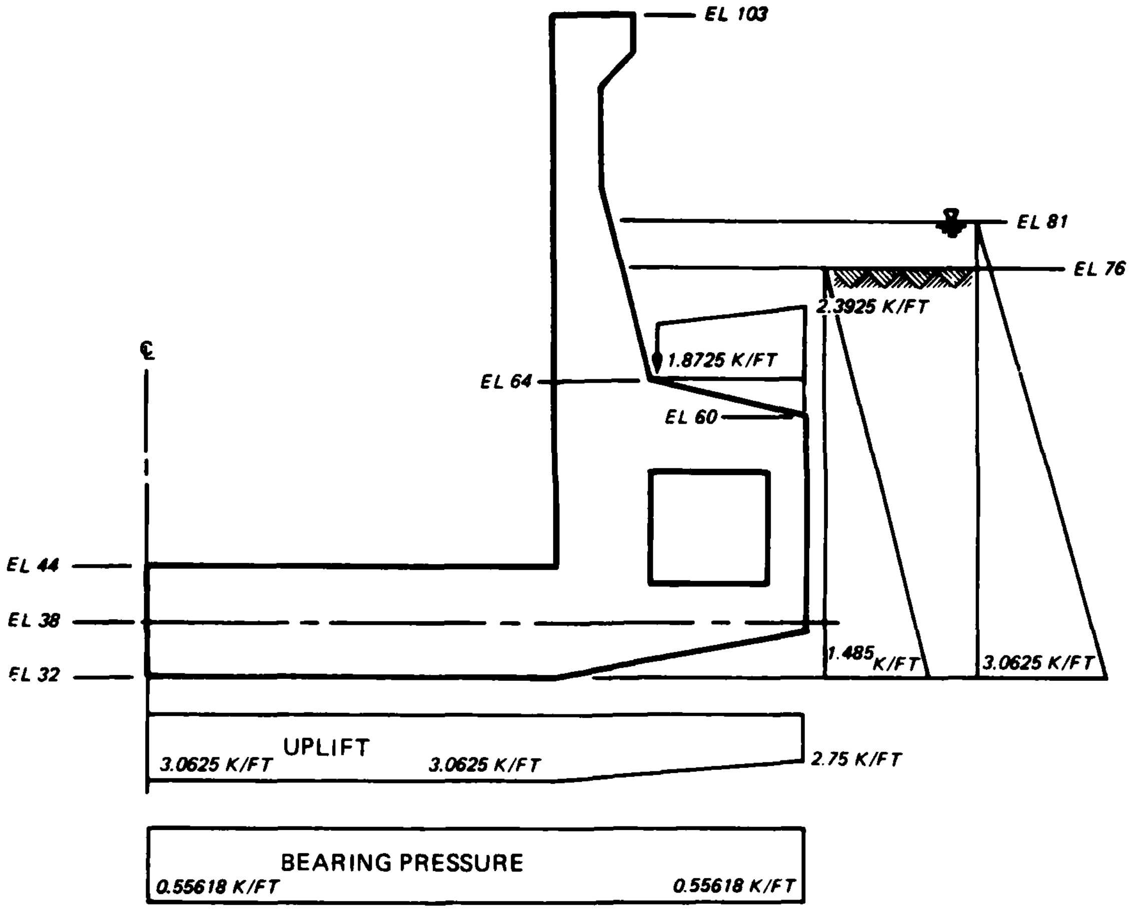

Figure 5. Load case 5A--extreme maintenance

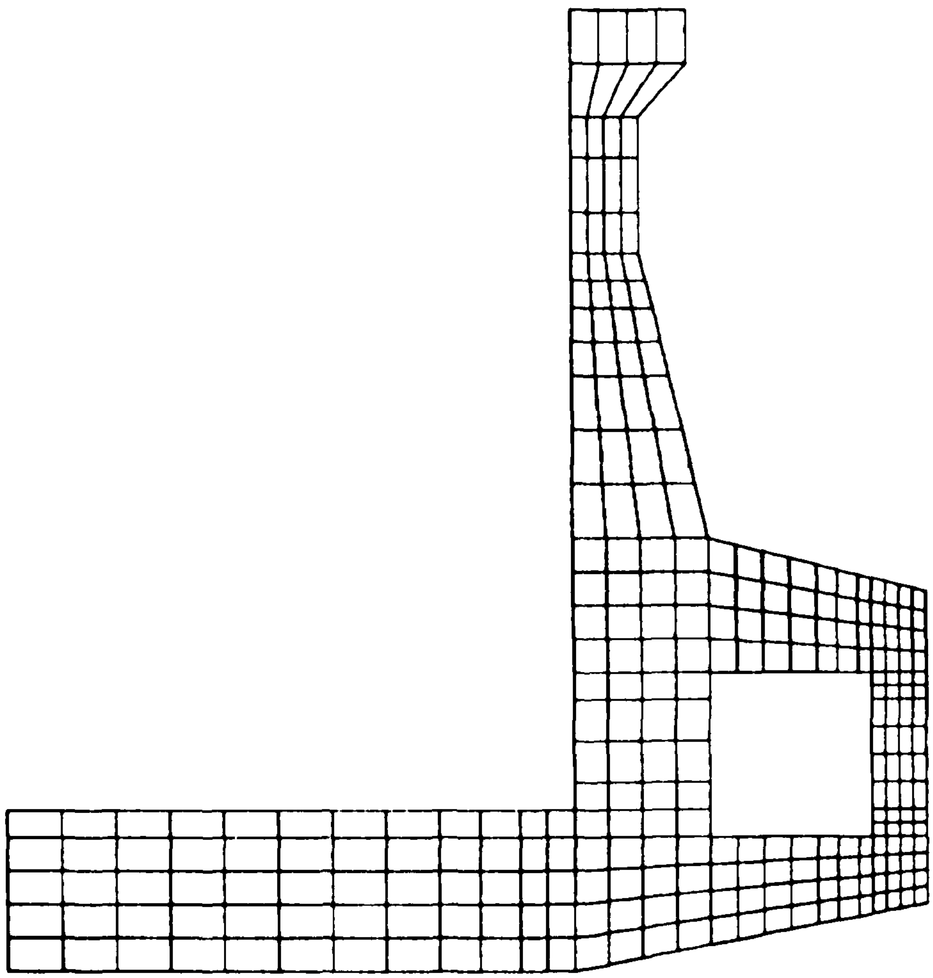

Figure 6. Detailed finite-element mathematical model of the Red River U-frame

various element nodes were used to calculate the average internal forces, axial and shear, and bending moments at the various sections of the U-frame using in-house developed computer program CSMT (Tracy, Hall, and Trahan 1983). The program CSMT calculates shear, moment, and axial forces for sections of a structure specified by the user, from stress results of a two-dimensional finite-element (FE) analysis. The bulk of the input is for geometry definition and the stress results from a FE analysis. The node and element data are read free field from one data file, and the stresses are read from another file. The remaining data are interactive commands to specify section information to obtain plots of grid, sections, and the results (shear, moment, and axial forces).

PART II: RESULTS

Joint Displacements

8. The joint displacements for the various nodal points (Figure 2) from the frame analysis using beam-column elements and the detailed plane-strain FE analyses were compared for the three different load cases, are shown in Tables 1 through 3. The percent difference between the displacements predicted by these two models is less than 5 percent, except for the horizontal displacements along the base slab. These horizontal displacements are two orders of magnitudes less than the vertical displacement and, therefore, do not result in a misrepresentation of the structural behavior. The graphical representation of the base-slab deflection and the wall deflection are shown in Figures 7 through 9.

Stress Plot

9. The normal stress, thrust, bending-stress, and shearing-stress plots for the various sections 1 through 18 and 1A through 10A (Figure 10) are performed using the CSMT computer program and are shown in Appendix A. It is important to note that the actual stress concentration occurs at the various junctions and should be considered in the design analysis.

Internal Forces

10. The in-house developed computer program CSMT calculated axial and shear forces and bending moments for the various sections in Figure 10 using the graphical stress plots in Appendix A. The axial forces, shear forces, and bending moments at the various sections (Figure 10) due to the simplified frame analysis using beam-column elements and the detailed plane-strain FE analyses were compared for the three load cases and are shown in the Tables 4 through 12. The internal forces agree well except at the member junctions, where heavy stress concentrations occur, and as such adjacent sections (1A through 10A in Figure 10) were investigated, they agree with that of the frame analysis. The graphical plots of bending moments, shear forces, and the axial

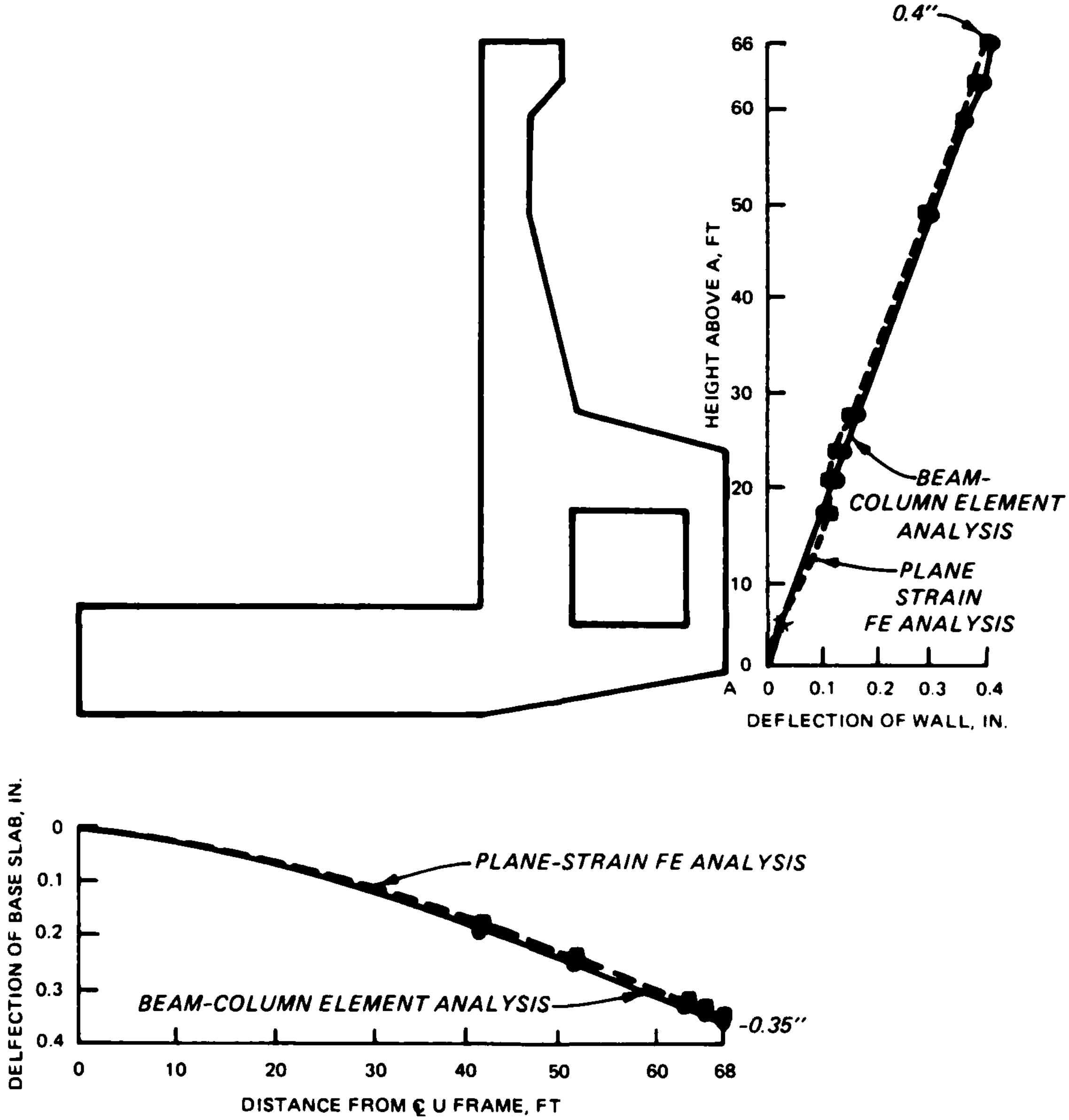

Figure 7. Case 1B--deflection shown in construction with backfill condition

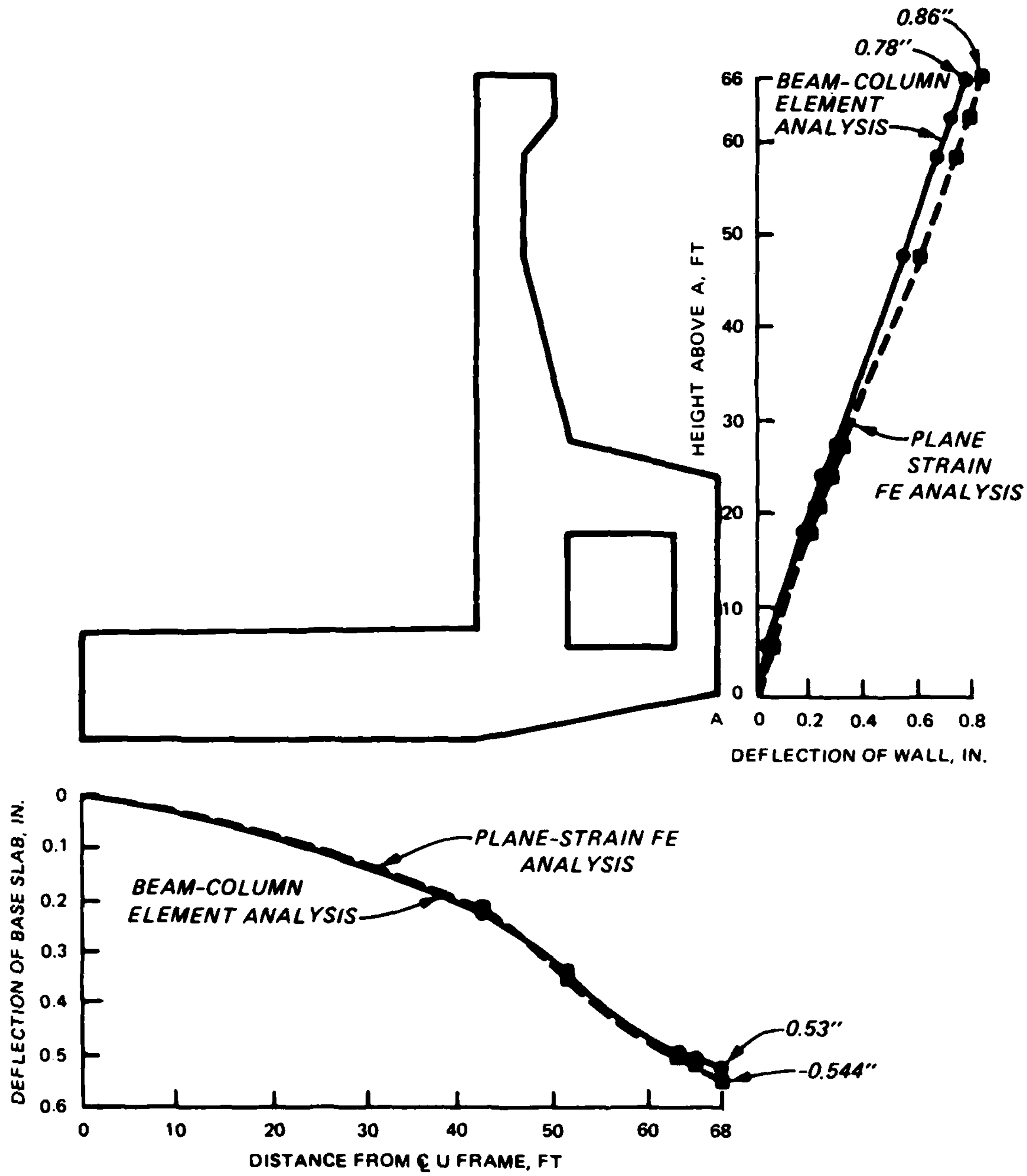

Figure 8. Case 2B--deflection in normal operating condition

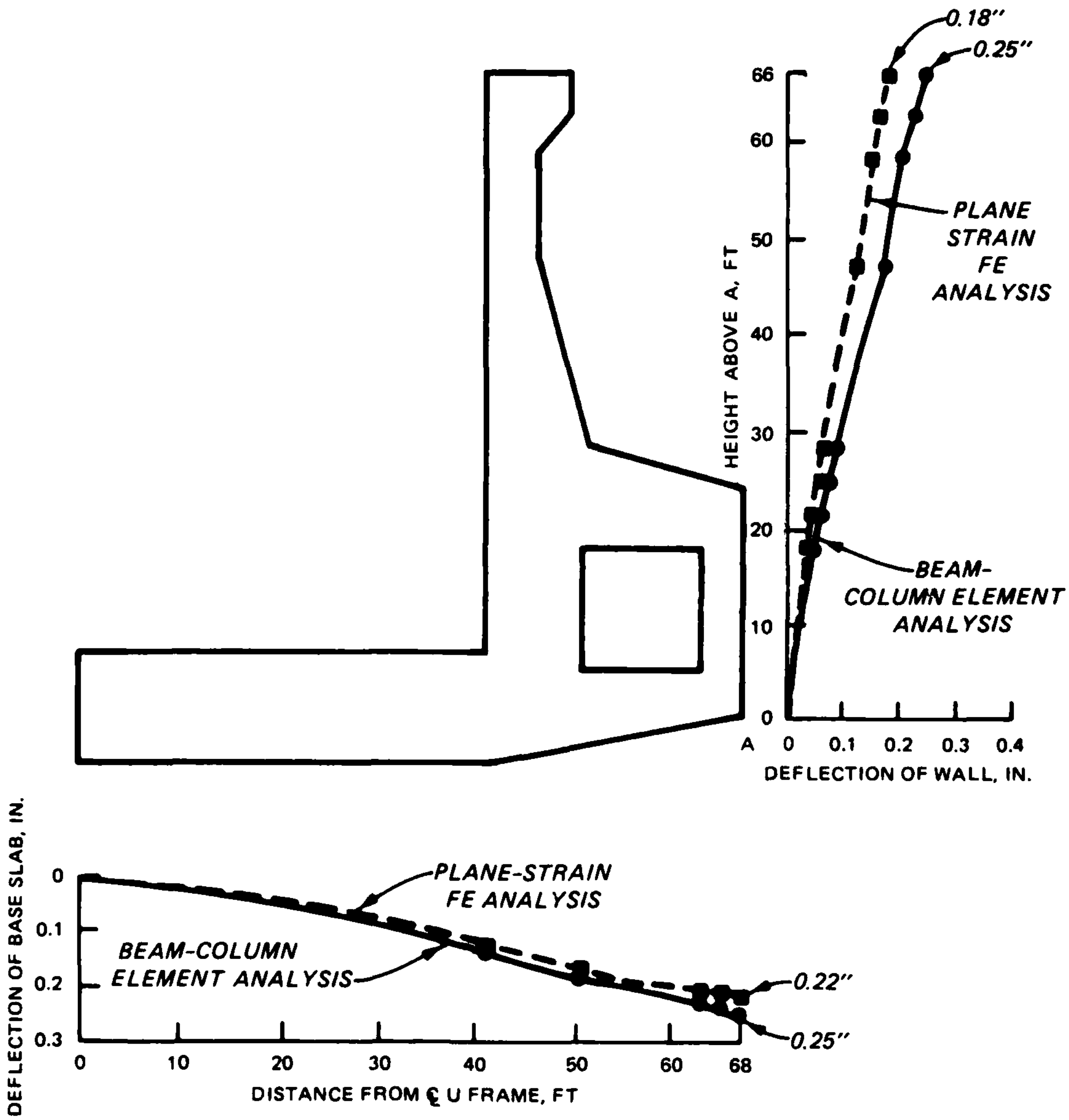

Figure 9. Case 5A--deflection shown in extreme maintenance condition

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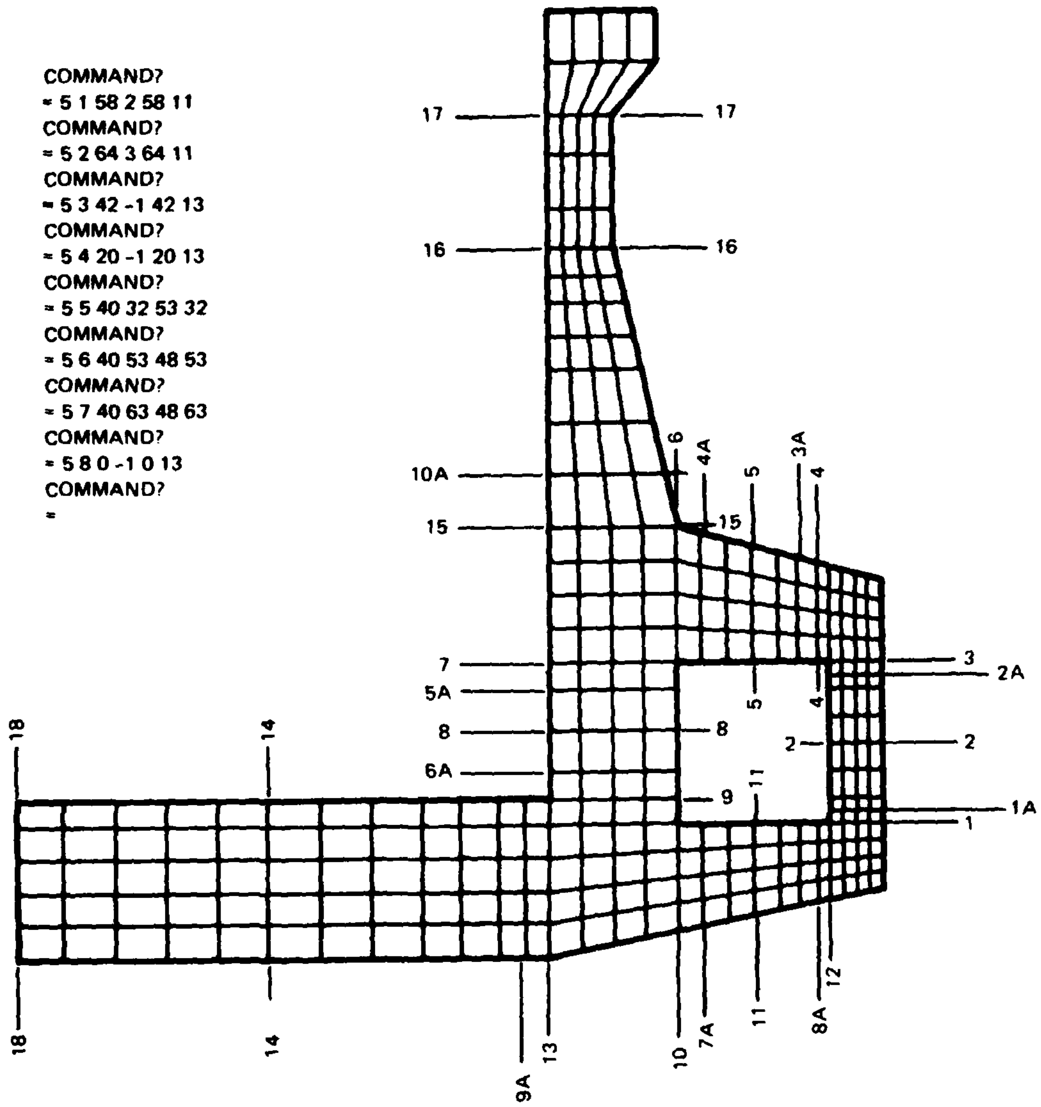

Figure 10. Various sections with FE model

forces for the three different load combinations are shown in Figures 11 through 13. It is to be noted that internal forces at sections 1A through 10A in Figure 10 were taken as the junction internal forces for the plot.

11. During the conduct of this study, Dr. William P. Dawkins completed a preliminary version of the computer program, CUFRAME, for the Computer-Aided Structural Engineering (CASE) project's task group on U-frame structures. CUFRAME uses the same planar rigid-frame analysis that was used for the GTSTRUDL analyses. CUFRAME was designed solely for analysis of U-frame lock structures and requires geometry data, soil data, and water elevation data. CUFRAME discretizes the geometry and uses of the soil and water elevation data to determine the loads on each member. The use of CUFRAME allowed the results shown in Tables 4 through 12 to be calculated in less than one hour as compared to several months for the GTSTRUDL results.

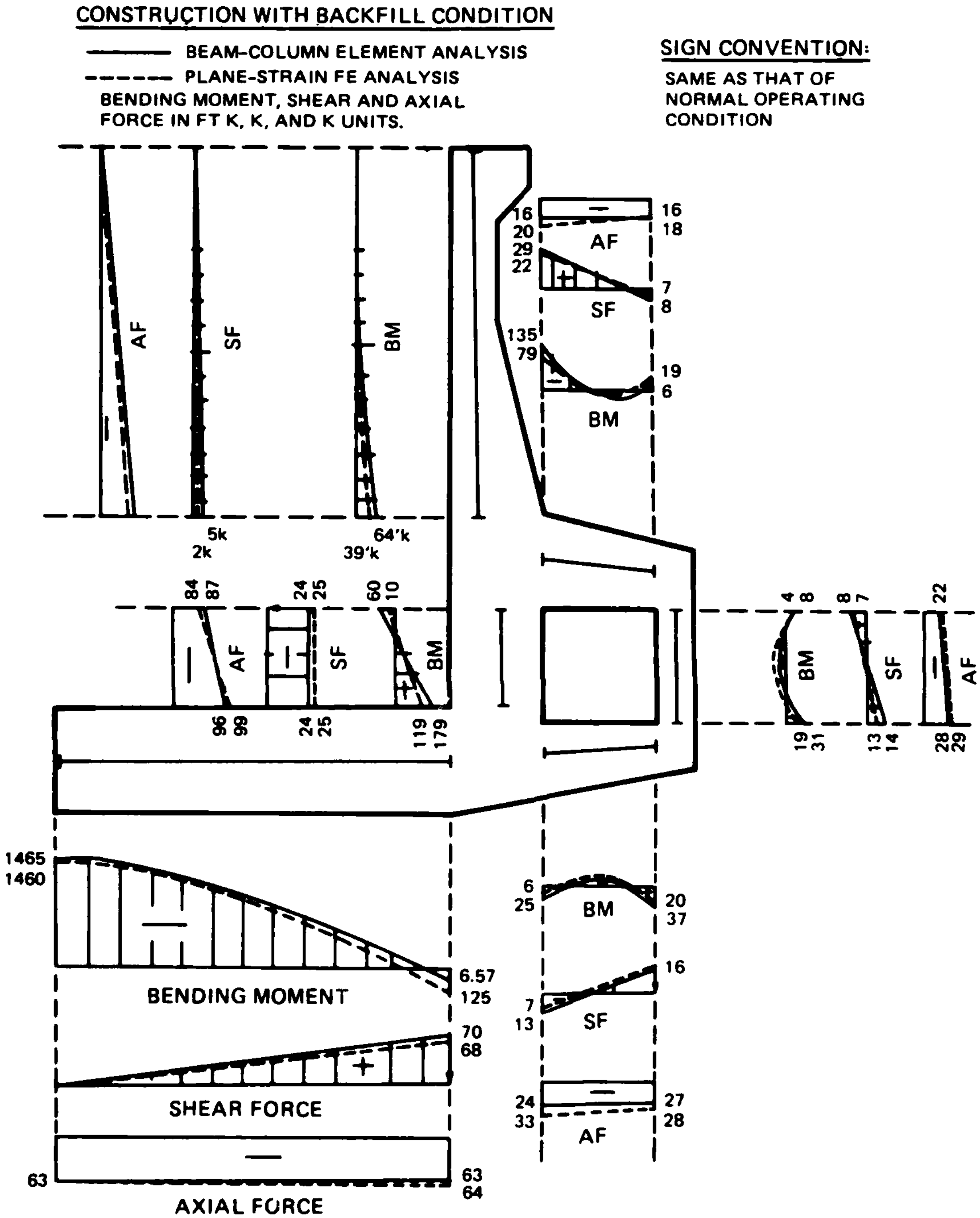

Figure 11. Case 1B--internal forces acting on construction with backfill condition

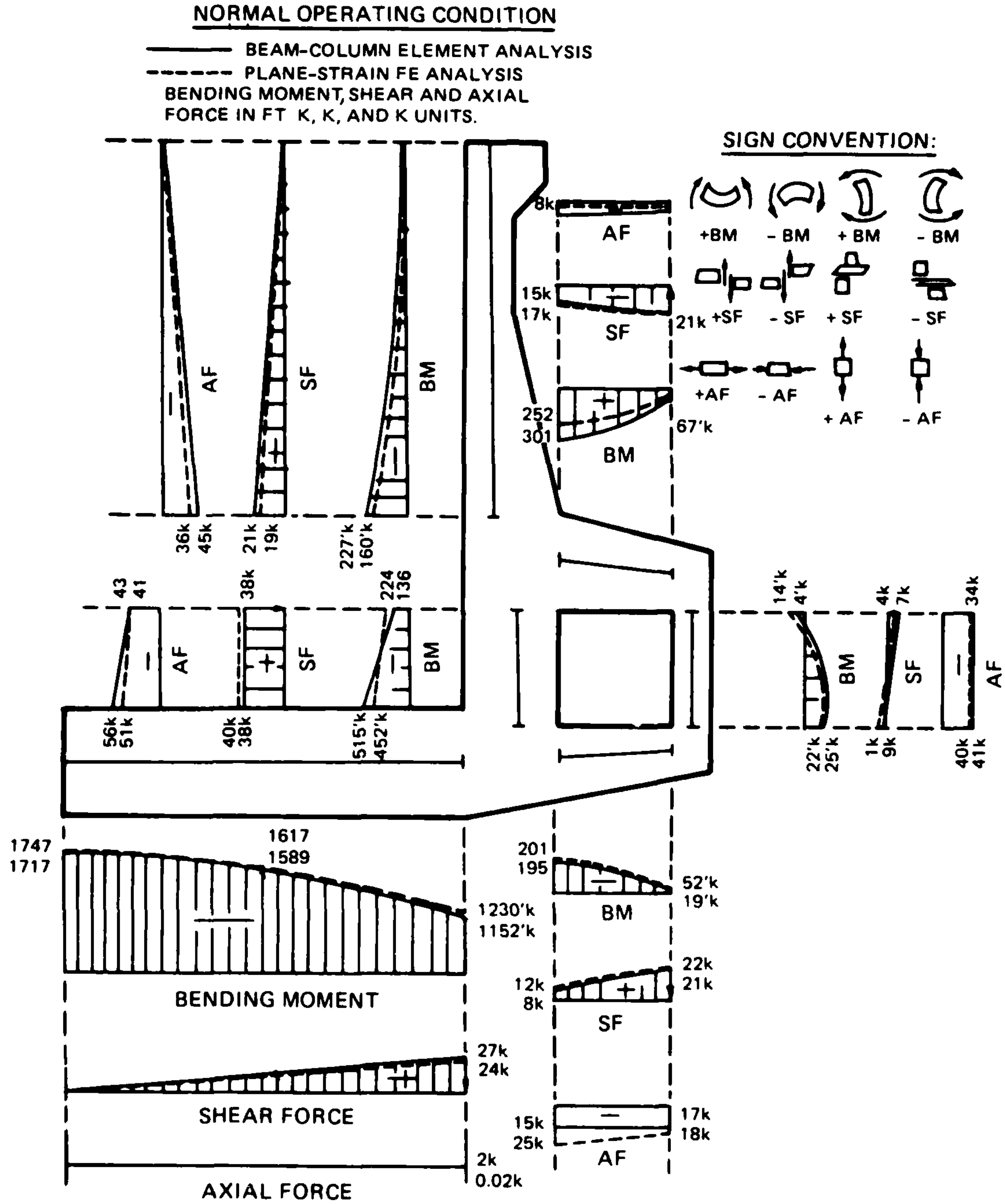

Figure 12. Case 2B--internal forces acting on normal operating condition

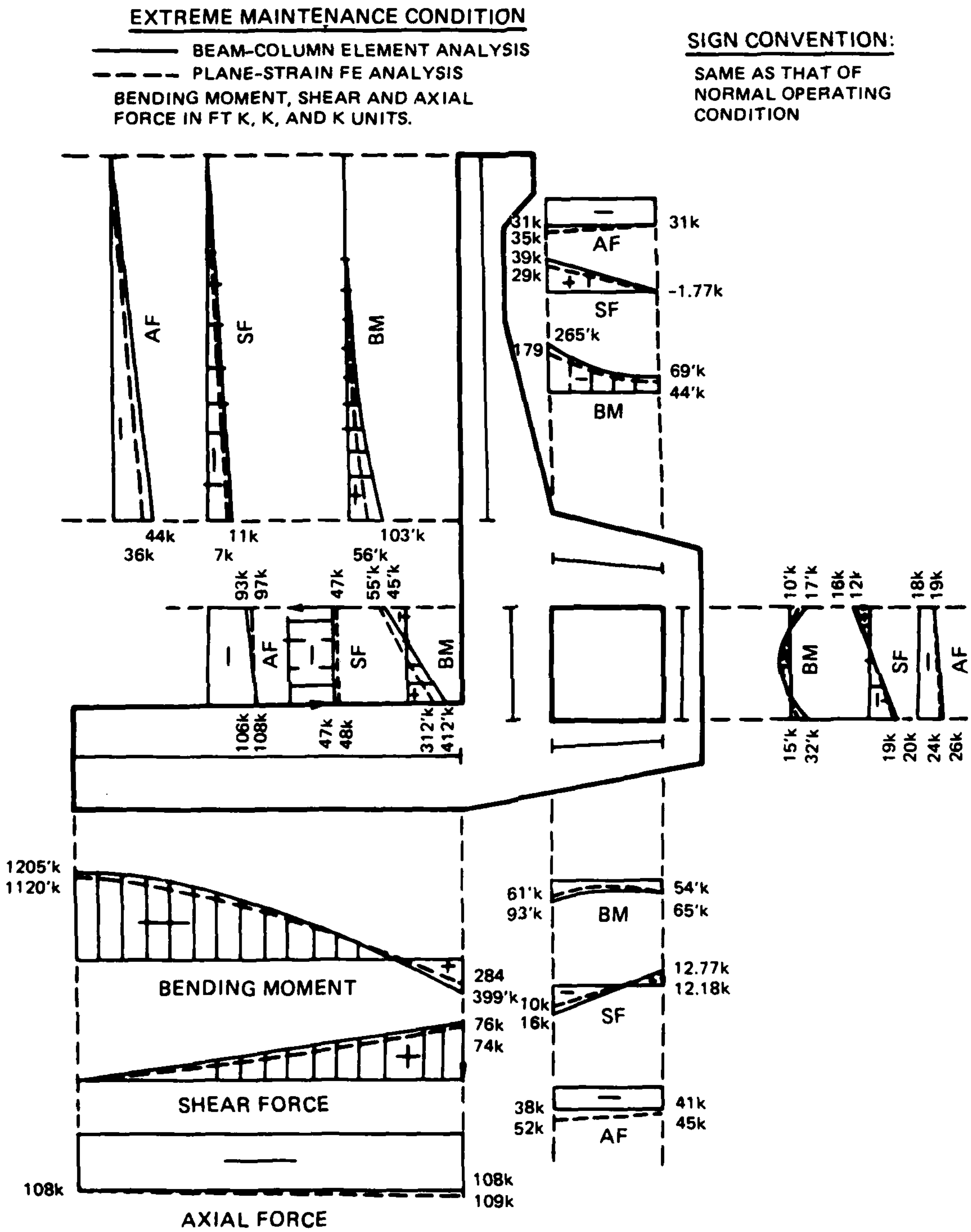

Figure 13. Case 5A--internal forces acting on extreme maintenance condition

PART III: CONCLUSIONS

12. Comparisons of the structural analysis of the Red River U-frame with a planar frame analysis using beam-column elements and that of detailed plane-strain finite-element model showed the following:

- *a*. Real soil-structure interaction effects have not been taken into account in either of the model analyses since loads were determined without knowing the final displacements.
- *b*. In the absence of real soil-structure interaction effects, the linearly elastic overall frame analysis of the U-frame structure agrees reasonably well with that of detailed plane-strain finite-element analysis, except at the juncture points. The displacements of the node points are also in agreement, while internal forces, except right at the juncture points, are similar. Stress concentration exists at the juncture as can be seen from the stress plots of Appendix A and elementary static's and strength of material's formulas may not be used to calculate the internal forces (bending moment, shear force, etc.). However, a little distance away from the juncture, the beam formula can be successfully applied. Therefore, in the absence of soil structure interaction effects, the frame model analysis and design of the overall U-frame structure is adequate except at the juncture, where detailed finite-element analysis is needed.
- *c*. In finite-element analysis equations of equilibrium are satisfied only in the mean throughout the element and, in general, pointwise equilibrium may not be satisfied within the element or along element juncture lines. It should be anticipated that some difficulties may be confronted in the interpretation of finite-element stress output. The best location for definition of the stress state for design would be at the centroid of each element. One can also calculate the average of the various stress components at the nodes, where a number of elements join. In isoparametric finite-element formulation, the element displacements at any point are directly related with element nodal-point displacements through the use of interpolation functions involving natural coordinates (Gallagher 1975; Bathe and Wilson 1976; Segerlind 1976; and Zeinkiewicz 1971).
- *d*. In view of the data analysis from the instrumentation program of Port Allen Lock (Sherman and Trahan 1968), Old River Lock (Sherman and Trahan 1972), and that the U-frame walls transfer the heavy load to the ground, the more or less uniform base soil-pressure distribution (Figures 3 through 5) may not be justified.
- *e*. Errors have been detected in some application of horizontal and vertical pressure loads locally in the frame model U-frame analysis. Pressures could have been applied in the global direction on the projected length of members.

f. The horizontal soil-pressure diagram (Figure 4) above the water line does not appear to be correct.

g. It is important that further research study should be extended to the analysis of linearly elastic U-frame structure on elastic foundation (Hetenyi 1971, Timoshenko and Woinowsky-Krieger 1959, Timoshenko and Goodier 1970). A relatively simple and useful computer program could be developed in a reasonable time. This research might be extended into the elasto-plastic (Clough 1969, Pande and Zienkiewicz 1982, and Hoffman and Sachs 1953) foundation study. Dynamic soil-structure interaction effects due to seismic loading may also be included in future investigations.

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Table 1

Case 1B--Deflection in Construction with Backfill, Without Earthquake

Frame Model Joint	FEM X Displacement in.	FEM Y Displacement in.	Frame X Displacement in.	Frame Y Displacement in.
1	0.00	0.00	0.0	0.0
2	-0.0029271	-0.1765026	-0.00523	-0.17746
3			-0.00591	-0.21118
4	-0.0052825	-0.241266	-0.00642	-0.24483
5	0.0010996	-0.3188311	0.00002	-0.32570
6	0.0022717	-0.3316765	0.00107	-0.33909
7	0.0034090	-0.3443291	0.00236	-0.35243
8	0.0191137	-0.3319080	0.01895	-0.33955
9	0.097427	-0.3334830	0.09796	-0.34136
10	0.1136865	-0.3337401	0.11984	-0.34178
11	0.1120579	-0.3465438	0.11816	-0.35520
12	0.1153249	-0.3209987	0.12164	-0.32838
13	0.1253805	-0.2439175	0.13220	-0.24852
14	0.0208578	-0.2098095	0.02095	-0.21215
15	0.0334889	-0.2101092	0.03434	-0.21263
16	0.0944080	-0.2119734	0.09980	-0.21481
17	0.1253082	-0.2126774	0.13243	-0.21576
18	0.1562741	-0.2133097	0.16508	-0.21631
19	0.2828945	-0.1999945	0.30040	-0.20201
20	0.3449428	-0.2005635	0.36609	-0.20262
21	0.3704964	-0.2118484	0.39294	-0.21448
22	0.3960874	-0.2118926	0.41985	-0.21451
23	-0.0149750	-0.3314818	-0.016404	-0.337848
24	0.1345276	-0.3339089	0.135888	-0.340536

Table 2

Case 2B--Deflection in Normal Operating, with Upper Pool

Frame Model Joint	FEM X Displacement in.	FEM Y Displacement in.	Frame X Displacement in.	Frame Y Displacement in.
1	0.0	0.0	0.0	0.0
2	0.0031655	-0.2329987	-0.00013	-0.23631
3			-0.00014	-0.28960
4	-0.0001865	-0.3455102	-0.00058	-0.34330
5	0.0132501	-0.4927854	0.01148	-0.48038
6	0.0156973	-0.5185946	0.01363	-0.50425
7	0.0181065	-0.5442583	0.01592	-0.52808
8	0.0501277	-0.5191073	0.04569	-0.50491
9	0.1955552	-0.5214308	0.18128	-0.50757
10	0.2333041	-0.5219483	0.21690	-0.50822
11	0.2303994	-0.5451386	0.21416	-0.53017
12	0.2361967	-0.4988702	0.21969	-0.48628
13	0.2543915	-0.3550763	0.23688	-0.35069
14	0.0439854	-0.2893636	0.04286	-0.29017
15	0.0667432	-0.2899749	0.06447	-0.29044
16	0.1906278	-0.2911323	0.17819	-0.29160
17	0.2542107	-0.2916415	0.23695	-0.29205
18	0.3182292	-0.2919328	0.29584	-0.29260
19	0.6038447	-0.2596522	0.55297	-0.26329
20	0.7462003	-0.2602082	0.68016	-0.26451
21	0.8038702	-0.2855444	0.73165	-0.28715
22	0.8615776	-0.2855885	0.78320	-0.28718
23	-0.0187361	-0.5182546	-0.016668	-0.503640
24	0.2712500	-0.5221949	0.244680	-0.507612

Table 3

Case 5A--Deflection in Extreme Maintenance

Frame Model Joint	FEM X Displacement in.	FEM Y Displacement in.	Frame X Displacement in.	Frame Y Displacement in.
1	0.0	0.0	0.0	0.0
2	-0.0068868	-0.1284984	-0.00394	-0.13630
3			-0.01011	-0.15935
4	-0.0090617	-0.1663310	-0.01091	-0.18219
5	-0.0068066	-0.2075054	-0.00773	-0.23422
6	-0.0063740	-0.2136300	-0.00731	-0.24231
7	-0.0059710	-0.2195485	-0.00653	-0.25033
8	0.0013590	-0.2137364	0.00338	-0.24272
9	0.0380905	-0.2149872	0.05379	-0.24432
10	0.0501485	-0.2151258	0.06857	-0.24468
11	0.0491539	-0.2224290	0.06744	-0.25370
12	0.0511549	-0.2078797	0.06991	-0.23571
13	0.0571094	-0.1663269	0.07738	-0.18435
14	0.0069197	-0.1484623	0.00805	-0.16041
15	0.0139670	-0.1486287	0.01703	-0.16093
16	0.0426947	-0.1505764	0.05804	-0.16332
17	0.0571434	-0.1512803	0.07780	-0.16438
18	0.0717463	-0.1519859	0.09758	-0.16494
19	0.1280442	-0.1470509	0.17810	-0.15717
20	0.1566077	-0.1476200	0.21769	-0.15778
21	0.1687674	-0.1530450	0.23409	-0.16508
22	0.1809646	-0.1530892	0.25056	-0.16511
23	-0.0147080	-0.2134902	-0.019908	-0.241788
24	0.0619024	-0.2152614	0.077280	-0.244140

Table 4

Case 1B--Construction Condition, Axial Force, kips

Section	Frame	Plane Strain	Section	Plane Strain	CUFRAM
1	28.96	30.17	1A	28.17	28.43
2	-25.36	-25.01			
3	-21.76	-22.25	2A	-22.09	-21.23
4	-17.74	-17.68	3A	-16.39	-16.30
5	-16.88	-17.84			
6	15.83	26.68	4A	19.80	14.41
7	-84.13	-89.87	5A	-87.28	-84.59
8	-91.62	-93.46			
9	99.12	105.97	6A	96.11	99.59
10	24.36	39.18	7A	33.34	33.71
11	-25.71	-31.00			
12	-27.06	-31.99	8A	-28.44	-30.39
13	-62.92	-80.74	9A	-64.37	-62.92
14	-62.92	-62.88			
15	-42.56	-43.56	10A	-35.37	-41.65
16	-16.56	-16.68			-16.53
17	-9.18	-9.88			9.15
18	62.92	62.88			62.92

Table 5

Case 1B--Construction Condition, Shear Force, kips

Section	Frame	Plane Strain	Section	Plane Strain	CUFRAM
1	-13.61	-14.52	1A	-12.64	-14.98
2	1.5200	2.22			
3	-8.23	-8.31	2A	-6.57	-6.86
4	7.65	10.85	3A	6.64	7.30
5	-10.48	-8.88			
6	28.75	31.75	4A	21.93	29.10
7	23.96	29.79	5A	24.60	22.59
8	23.96	24.45			
9	-23.96	-32.67	6A	-24.85	-22.59
10	-13.16	-14.27	7A	-7.10	-14.67
11	-0.9163	-2.78			
12	-15.88	-22.67	8A	-16.01	-14.95
13	-70.14	-78.05	9A	-68.37	-70.09
14	-33.3744	-34.69			
15	4.68	3.41	10A	2.28	9.67
16	-1.97	-0.0864			-1.97
17	-0.0000	-0.53			0.0
18	-0.0456	-0.0099			0.0

Table 6

Case 1B--Construction Condition, Moment, M_z , kip-feet

Section	Frame	Plane Strain	Section	Plane Strain	CUFRAM
1	-30.82	-3.37	1A	-18.76	-41.19
2	-14.5700	-15.58			
3	7.93	16.56	2A	4.06	1.77
4	-18.97	-0.2448	3A	-5.98	-9.06
5	-17.14	-17.35			
6	134.83	130.72	4A	79.16	129.1
7	-60.14	-2.89	5A	-10.34	-63.44
8	59.69	56.87			
9	-179.49	-91.74	6A	-118.54	-162.4
10	-25.19	-17.52	7A	-6.13	-20.82
11	-11.9604	-18.66			
12	37.48	31.20	8A	19.70	39.63
13	6.57	84.53	9A	125.38	8.86
14	-1132.05	-1129.54			
15	64.32	58.95	10A	38.85	64.80
16	12.50	12.63			12.78
17	-12.50	-12.28			-12.77
18	1465.34	1460.16			1473.00

Table 7

Case 2B--Normal Operation, Axial Force, kips

Section	Frame	Plane Strain	Section	Plane Strain	CUFRAM
1	40.9782	47.3328	1A	40.0320	39.22
2	-37.3782	-37.4112			
3	-33.7782	-39.0816	2A	-34.0272	-32.02
4	-6.2815	-9.7920	3A	-5.8464	-6.758
5	-6.1133	-5.4864			
6	8.0583	4.8816	4A	6.9696	8.814
7	-41.2954	-42.3504	5A	-42.8688	-43.06
8	-48.7954	-46.0512			
9	56.2954	40.4208	6A	50.7168	58.06
10	15.6427	12.4560	7A	25.4880	25.32
11	-16.2461	-20.4480			
12	-16.8495	-21.4992	8A	-17.7120	-18.38
13	-1.5395	-60.5232	9A	-0.3456	-2.361
14	-1.5395	-0.0432			
15	44.7414	37.8576	10A	35.6544	45.20
16	-16.9027	-16.6464			-16.90
17	-9.1500	-9.8784			-9.150
18	1.5395	0.0288			2.361

Table 8

Case 2B--Normal Operation, Shear Force, kips

Section	Frame	Plane Strain	Section	Plane Strain	CUFRAM
1	0.8917	1.9584	1A	1.3824	1.873
2	2.2058	0.7344			
3	6.5183	5.8032	2A	4.0320	5.536
4	21.2028	21.5856	3A	21.4992	19.37
5	-18.3828	-19.0368			
6	-15.3270	-15.3216	4A	-17.4672	-13.46
7	-37.8563	-38.5488	5A	-38.6496	-40.77
8	-37.8563	-39.1968			
9	37.8563	58.3200	6A	40.4064	40.77
10	8.3919	15.2496	7A	11.9808	5.581
11	-14.6088	-16.0992			
12	-21.3755	-24.0192	8A	-22.0032	-19.39
13	-26.9587	-1.5984	9A	-23.8176	-26.86
14	-12.8259	-13.4064			
15	21.4513	16.2864	10A	19.2240	20.15
16	1.1348	3.2400			1.135
17	0.0000	0.5184			0.0
18	-0.0221	-0.0720			0.0

Table 9

Case 2B--Normal Operation, Moment, M_z , kip-feet

Section	Frame	Plane Strain	Section	Plane Strain	CUFRAM
1	-24.5916	-5.6736	1A	-22.3344	-20.12
2	20.0418	25.7904			
3	-4.3079	-11.8656	2A	-13.7088	-3.008
4	66.3829	34.9056	3A	67.2048	53.76
5	394.7964	170.6400			
6	-301.4196	-224.9280	4A	-231.8400	-264.5
7	-136.0537	-116.2368	5A	-223.6320	-234.2
8	-325.3350	-347.4720			
9	514.6165	624.0960	6A	451.7280	641.9
10	195.4966	291.6000	7A	201.0240	216.7
11	-126.4857	-149.7600			
12	-18.5451	-24.3648	8A	-52.0128	-39.99
13	-1151.5437	-1568.1600	9A	-1230.0480	-1281.0
14	-1589.1734	-1617.1200			
15	-227.1848	-204.4800	10A	-160.1280	-245.5
16	22.8689	22.7664			23.19
17	-12.4522	-12.2400			-12.77
18	1717.2117	1746.7200			1845.0

Table 10

Case 5A--Extreme Maintenance, Axial Force, kips

Section	Frame	Plane Strain	Section	Plane Strain	CUFRAM
1	25.99	26.57	1A	24.39	26.07
2	-22.39	-20.97			
3	-18.79	-18.38	2A	-18.26	-18.87
4	-30.71	-31.68	3A	-28.97	-28.05
5	-30.52	-32.21			
6	30.52	45.65	4A	34.79	27.87
7	-93.12	-101.51	5A	-96.57	-93.03
8	-100.62	-103.64			
9	108.12	124.76	6A	105.85	108.0
10	38.20	65.39	7A	51.74	53.81
11	-40.86	-49.02			
12	-40.86	-48.99	8A	-44.57	-46.79
13	-107.63	-153.50	9A	-109.31	-107.7
14	-107.63	-107.65			
15	-43.58	-45.86	10A	-36.07	-41.92
16	-16.56	-16.68			-16.53
17	-9.18	-9.88			-9.15
18	107.63	107.65			107.7

Table 11

Case 5A--Extreme Maintenance, Shear Force, kips

Section	Frame	Plane Strain	Section	Plane Strain	CUFRAM
1	-20.43	-22.56	1A	-19.28	-23.18
2	0.65	2.28			
3	-15.66	-15.74	2A	-12.23	-12.91
4	1.77	6.80	3A	1.54	2.202
5	-18.58	-15.02			
6	38.63	41.39	4A	29.38	38.20
7	46.54	53.63	5A	47.03	43.85
8	46.54	47.02			
9	-46.54	-64.02	6A	-47.85	-43.85
10	-16.34	-19.83	7A	-10.11	-17.89
11	2.47	0.17			
12	-12.18	-20.69	8A	-12.77	-11.56
13	-76.38	-94.32	9A	-74.13	-76.35
14	-36.37	-36.48			
15	-11.46	-9.04	10A	-6.82	-16.53
16	-1.97	-0.09			-1.968
17	-0.00	-0.53			0.0
18	-0.00001	-1.27			0.0

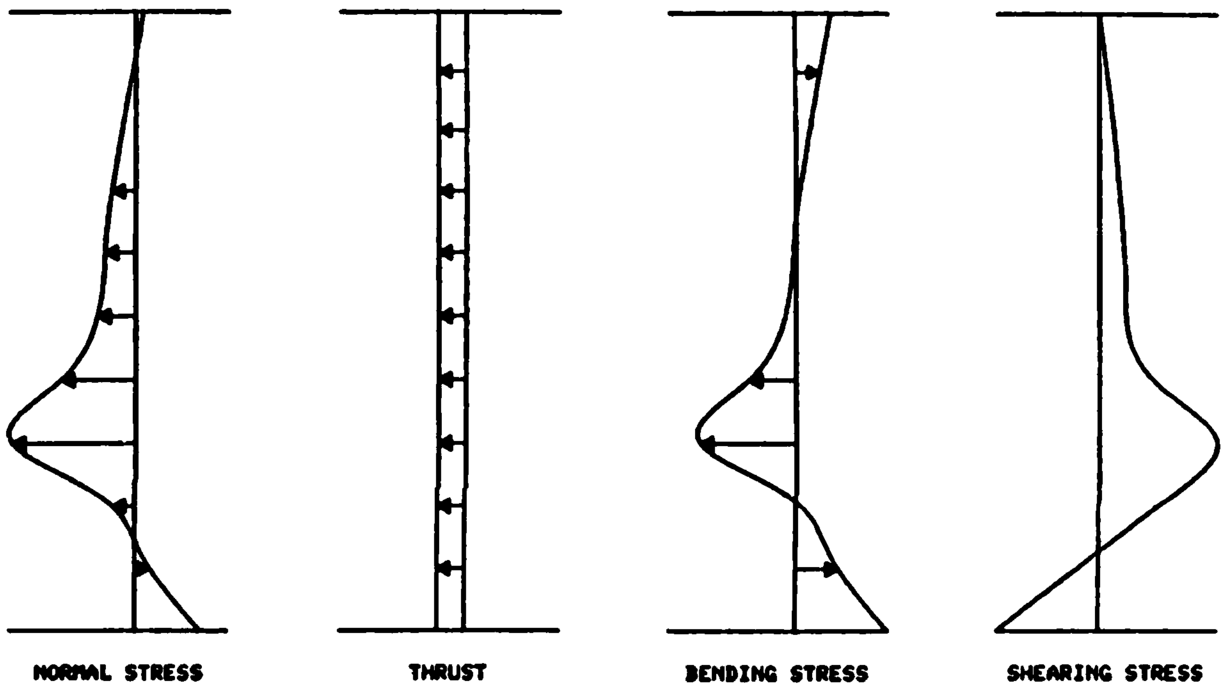
Table 12

Case 5A--Extreme Maintenance, Moment, M_z , kip-feet

Section	Frame	Plane Strain	Section	Plane Strain	CUFRAM
1	-31.55	-9.72	1A	-14.82	-51.66
2	-29.965	-35.87			
3	16.84	12.90	2A	9.98	3.848
4	-69.09	-23.56	3A	-44.02	-40.42
5	-91.04	-90.43			
6	264.99	234.72	4A	178.56	237.0
7	-44.50	-21.28	5A	-55.34	-29.21
8	188.21	190.51			
9	-420.91	-351.94	6A	-312.48	-409.3
10	-92.50	-109.86	7A	-60.97	-78.27
11	36.69	36.36			
12	65.10	55.53	8A	53.94	71.75
13	399.43	658.66	9A	283.96	388.3
14	-840.80	-783.94			
15	103.19	91.58	10A	56.30	103.5
16	12.50	12.63			-12.78
17	-12.50	-12.28			-12.78
18	1204.65	1120.18			-1215.0

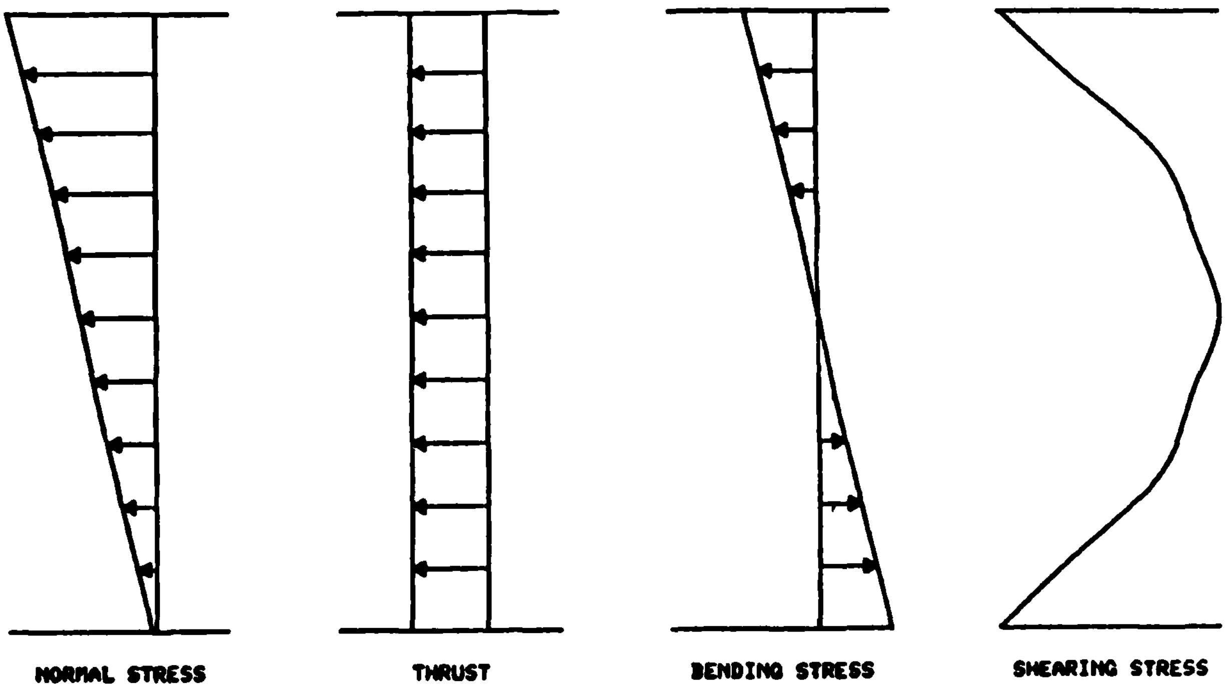
APPENDIX A: STRESS-PLOT AND INTERNAL-FORCES CALCULATION FOR VARIOUS SECTIONS OF THREE LOAD COMBINATIONS

NOTE: THE INTERNAL FORCES AND MOMENTS ARE TO BE MULTIPLIED BY 144 TO GET INTO KIPS AND KIP-FT UNITS



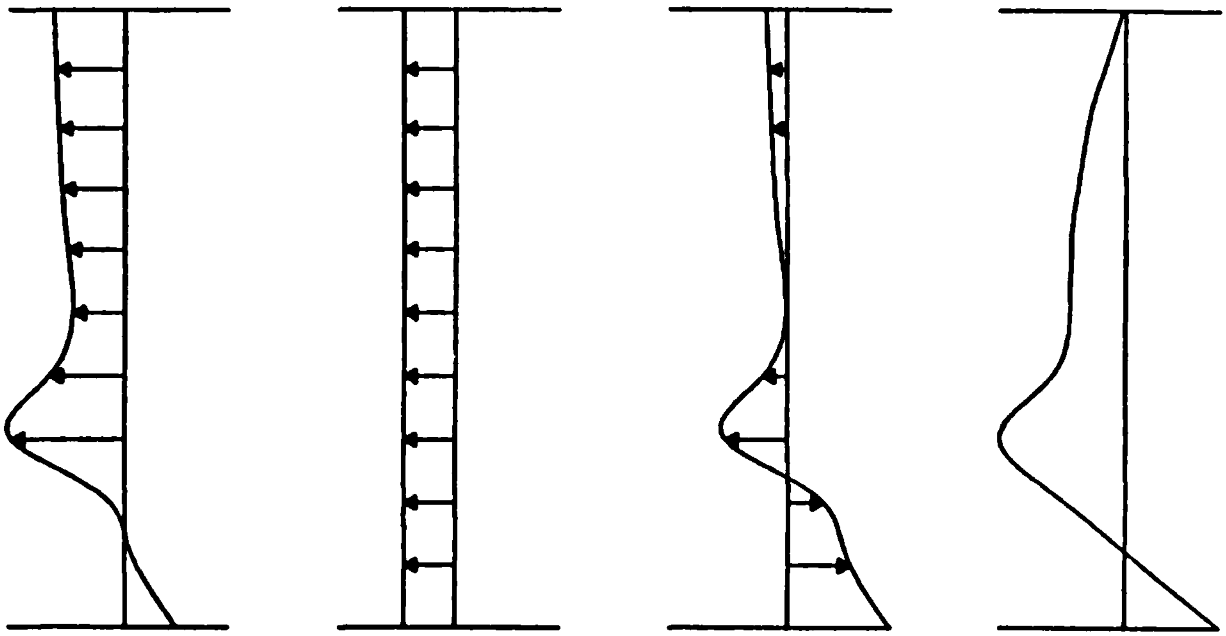
(X1, Y1) = (62.,10.)
(X2, Y2) = (70.,10.)
NEUTRAL AXIS = (66.03,10.)
SHEAR = .1008
MOMENT = -.0234
THRUST = -.2095

Figure A1. Load case 1B (section 1)



(X1, Y1) = (62.,16.)
(X2, Y2) = (70.,16.)
NEUTRAL AXIS = (66.,16.)
SHEAR = .0154
MOMENT = .1082
THRUST = -.1737

Figure A2. Load case 1B (section 2)



NORMAL STRESS　　THRUST　　BENDING STRESS　　SHEARING STRESS

(X1, Y1) = (62.,22.)
(X2, Y2) = (70.,22.)
NEUTRAL AXIS = (63.63,22.)
SHEAR = -.0577
MOMENT = .115
THRUST = -.1546

Figure A3. Load case 1B (section 3)

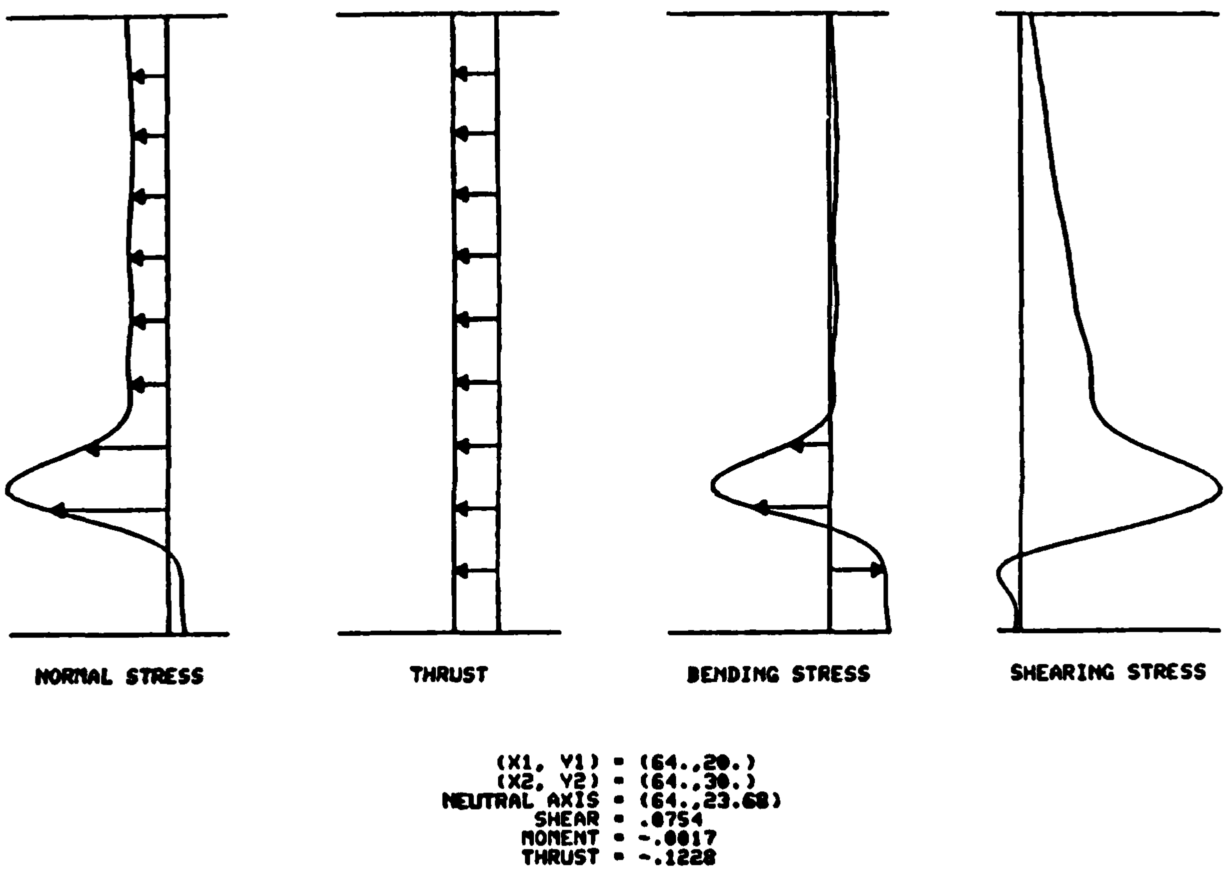


Figure A4. Load case 1B (section 4)

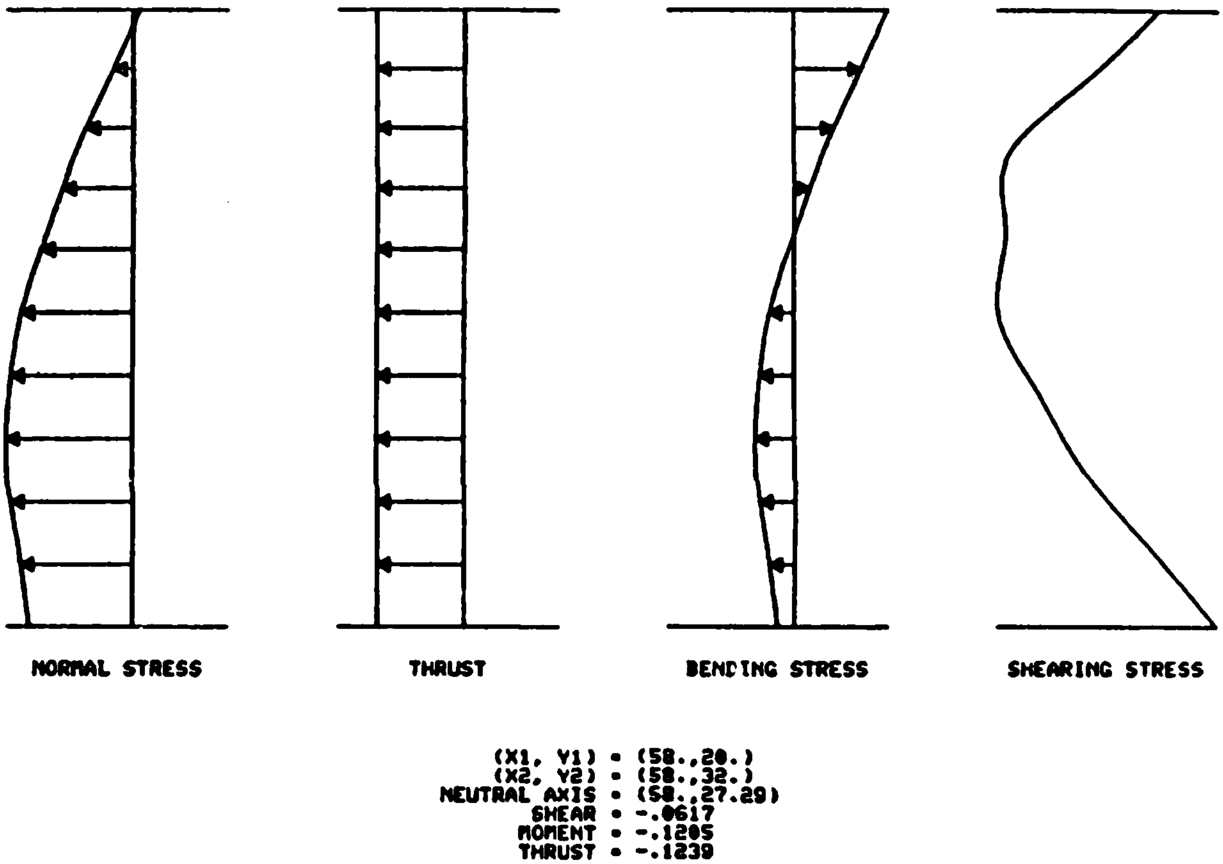
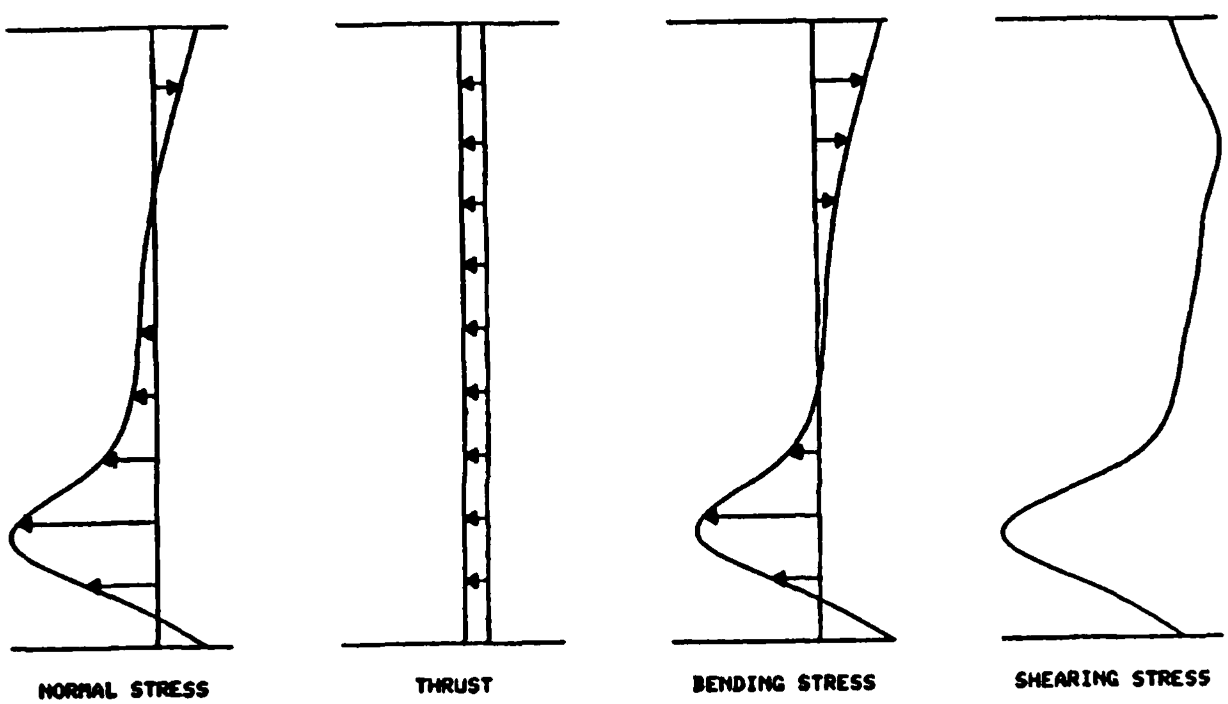
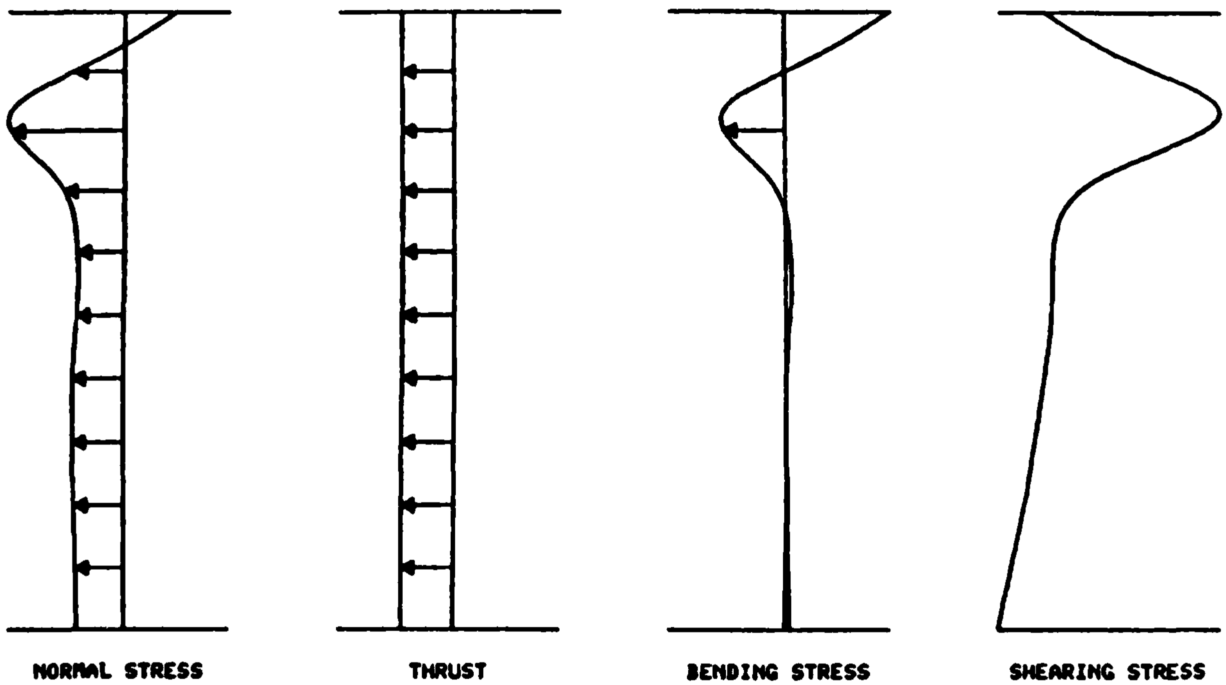


Figure A5. Load case 1B (section 5)



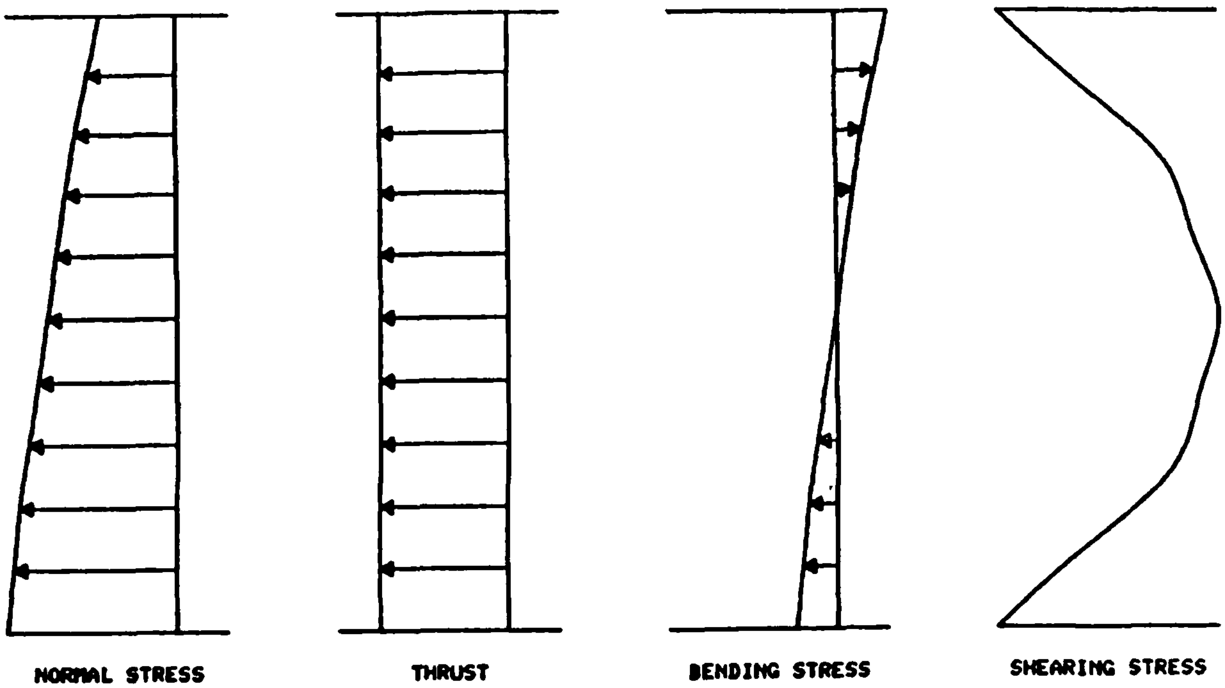
(X1, Y1) = (52.,20.)
(X2, Y2) = (52.,33.)
NEUTRAL AXIS = (52.,25.03)
SHEAR = -.2205
MOMENT = -.9078
THRUST = -.1853

Figure A6. Load case 1B (section 6)



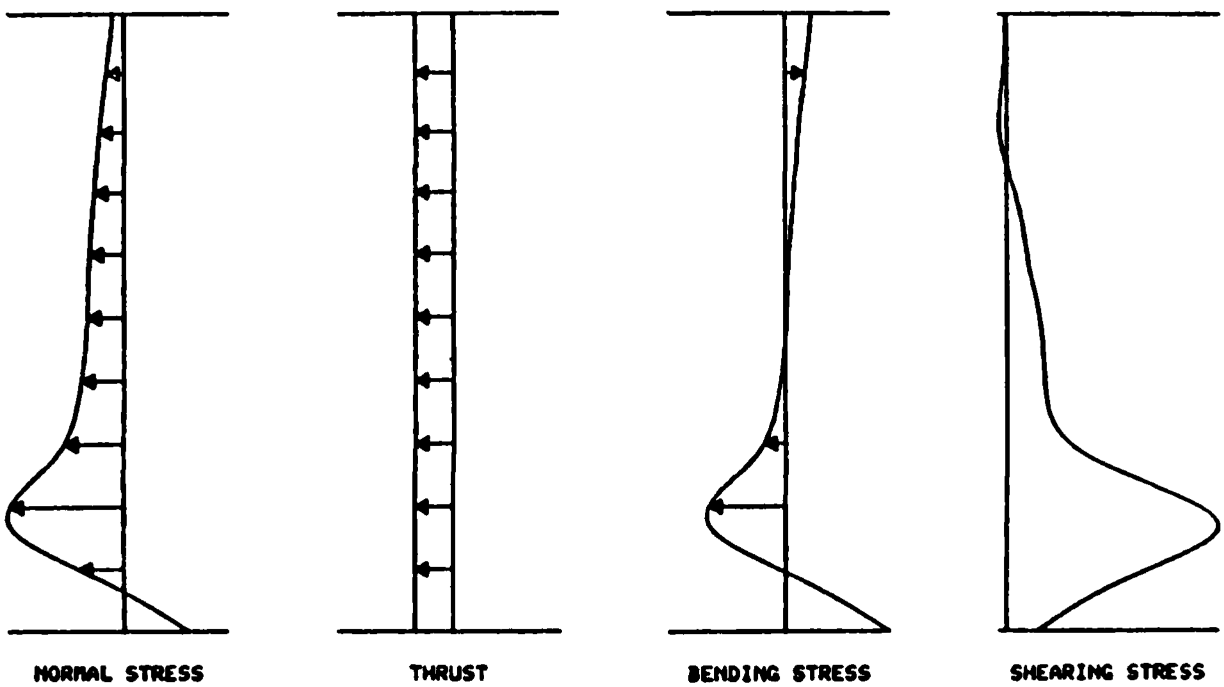
(X1, Y1) = (40.,22.)
(X2, Y2) = (54.,22.)
NEUTRAL AXIS = (52.74,22.)
SHEAR = .2069
MOMENT = -.0201
THRUST = -.6241

Figure A7. Load case 1B (section 7)



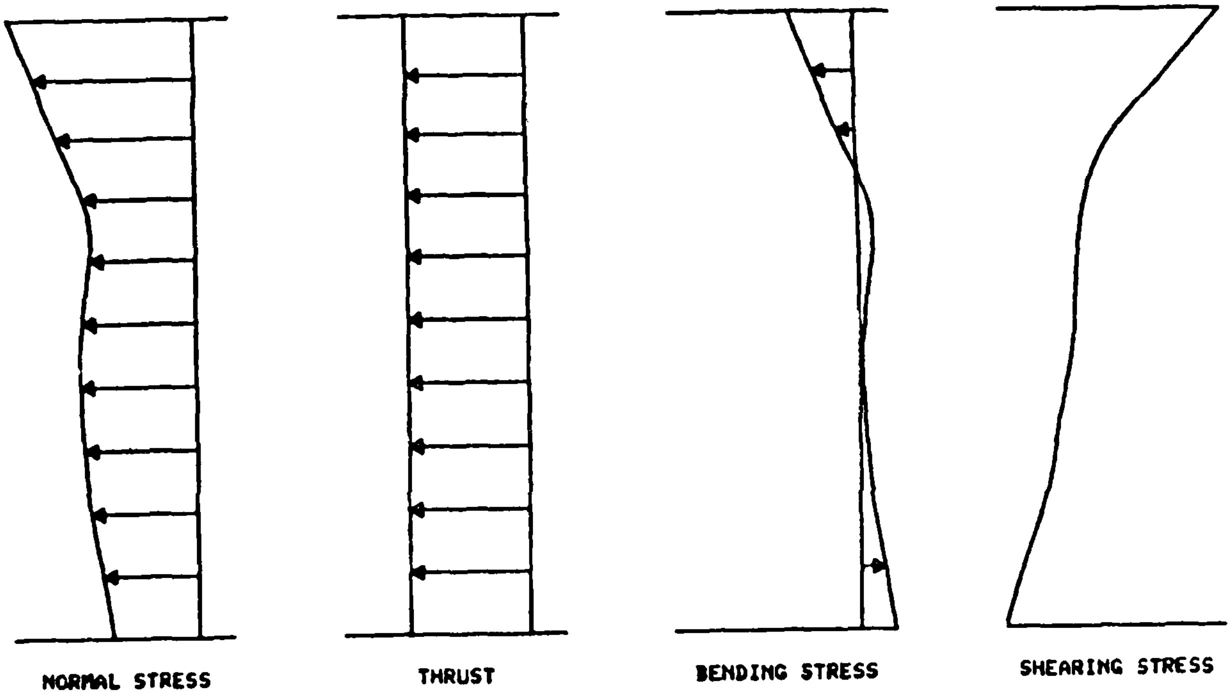
(X1, Y1) = (40.,17.)
(X2, Y2) = (54.,17.)
NEUTRAL AXIS = (47.14,17.)
SHEAR = .1698
MOMENT = -.3949
THRUST = -.649

Figure A8. Load case 1B (section 8)



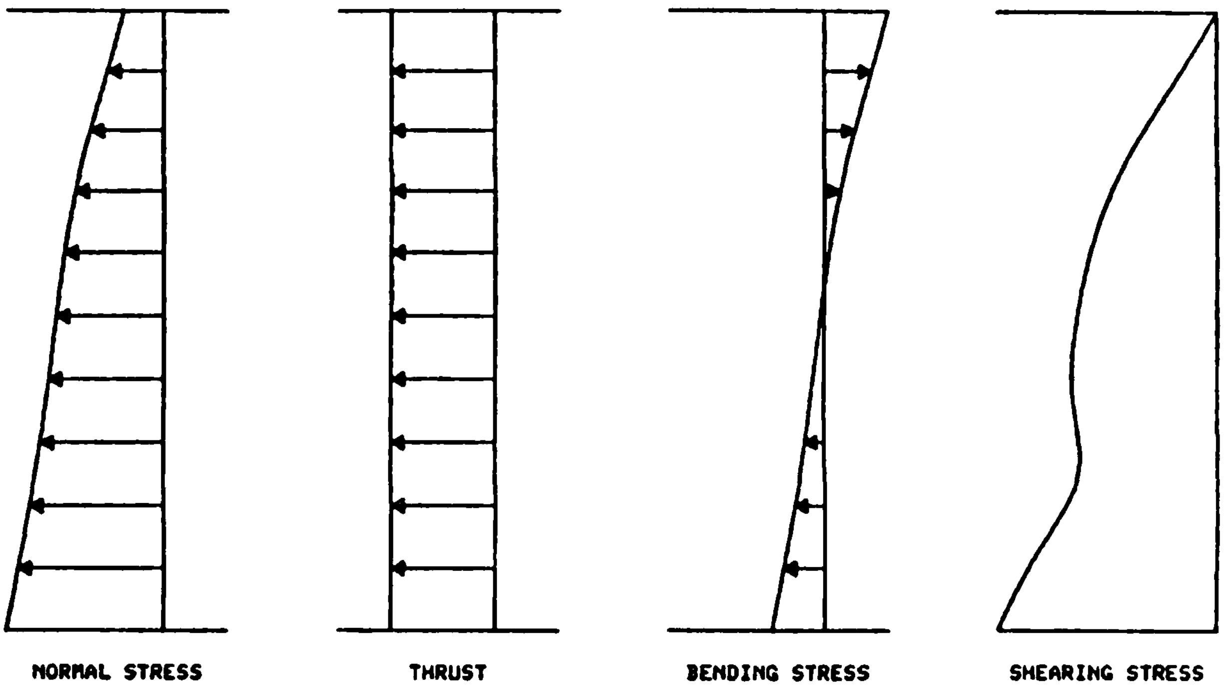
(X1, Y1) = (40.,12.)
(X2, Y2) = (54.,12.)
NEUTRAL AXIS = (45.64,12.)
SHEAR = .2269
MOMENT = -.6371
THRUST = -.7359

Figure A9. Load case 1B (section 9)



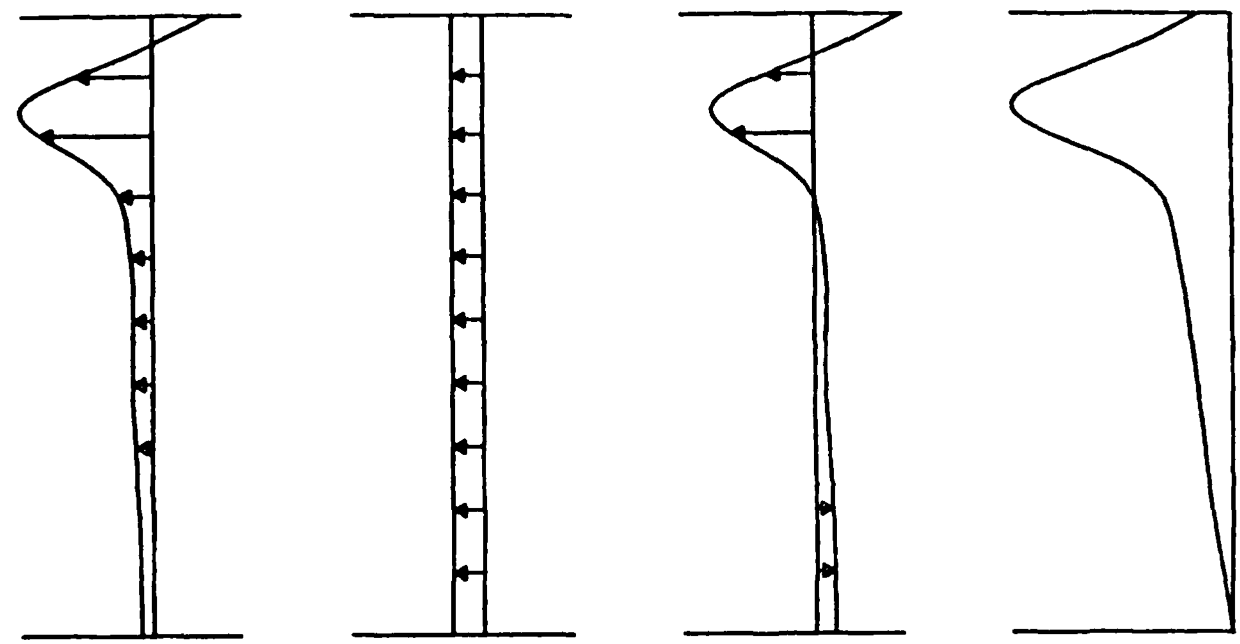
(X1, Y1) = (52.,1.)
(X2, Y2) = (52.,11.)
NEUTRAL AXIS = (52.,8.483)
SHEAR = .0991
MOMENT = .1217
THRUST = -.2721

Figure A10. Load case 1B (section 10)



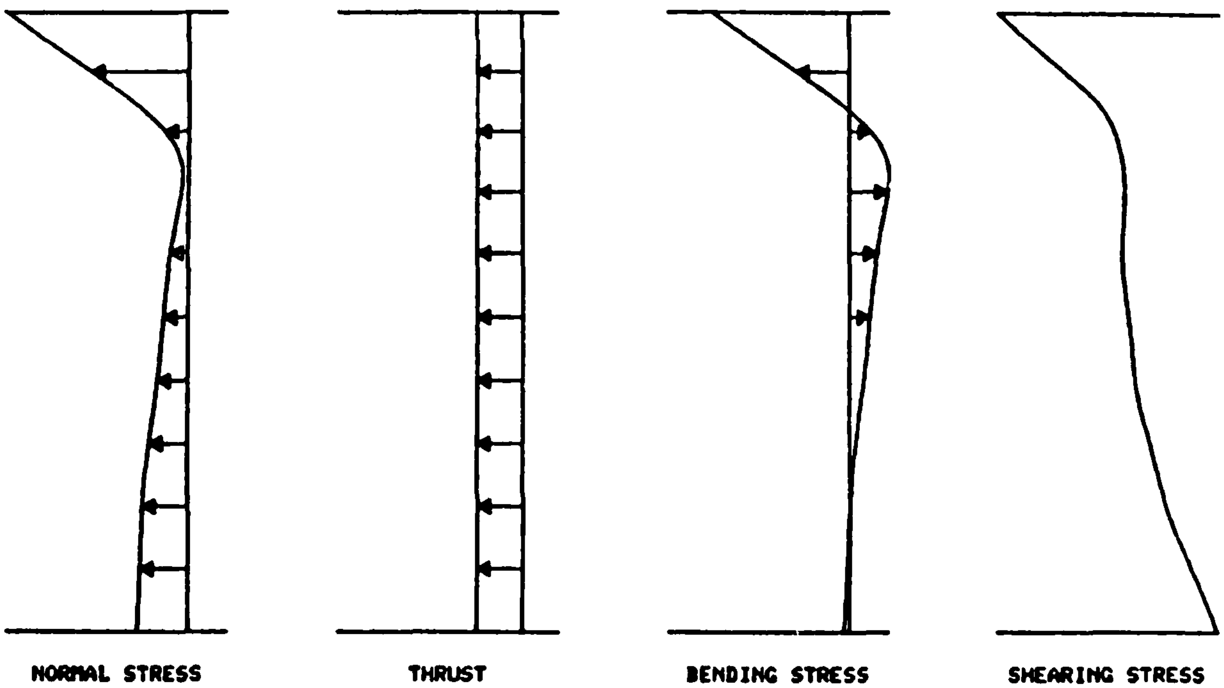
(X1, Y1) = (58.,2.)
(X2, Y2) = (58.,11.)
NEUTRAL AXIS = (58.,6.821)
SHEAR = -.0193
MOMENT = -.1296
THRUST = -.2153

Figure A11. Load case 1B (section 11)



(X1, Y1) = (64.,3.)
(X2, Y2) = (64.,11.)
NEUTRAL AXIS = (64.,10.53)
SHEAR = -.1574
MOMENT = .2167
THRUST = -.2222

Figure A12. Load case 1B (section 12)



(X1, Y1) = (42.,-1.)
(X2, Y2) = (42.,13.)
NEUTRAL AXIS = (42.,10.79)
SHEAR = -.542
MOMENT = .587
THRUST = -.5607

Figure A13. Load case 1B (section 13)

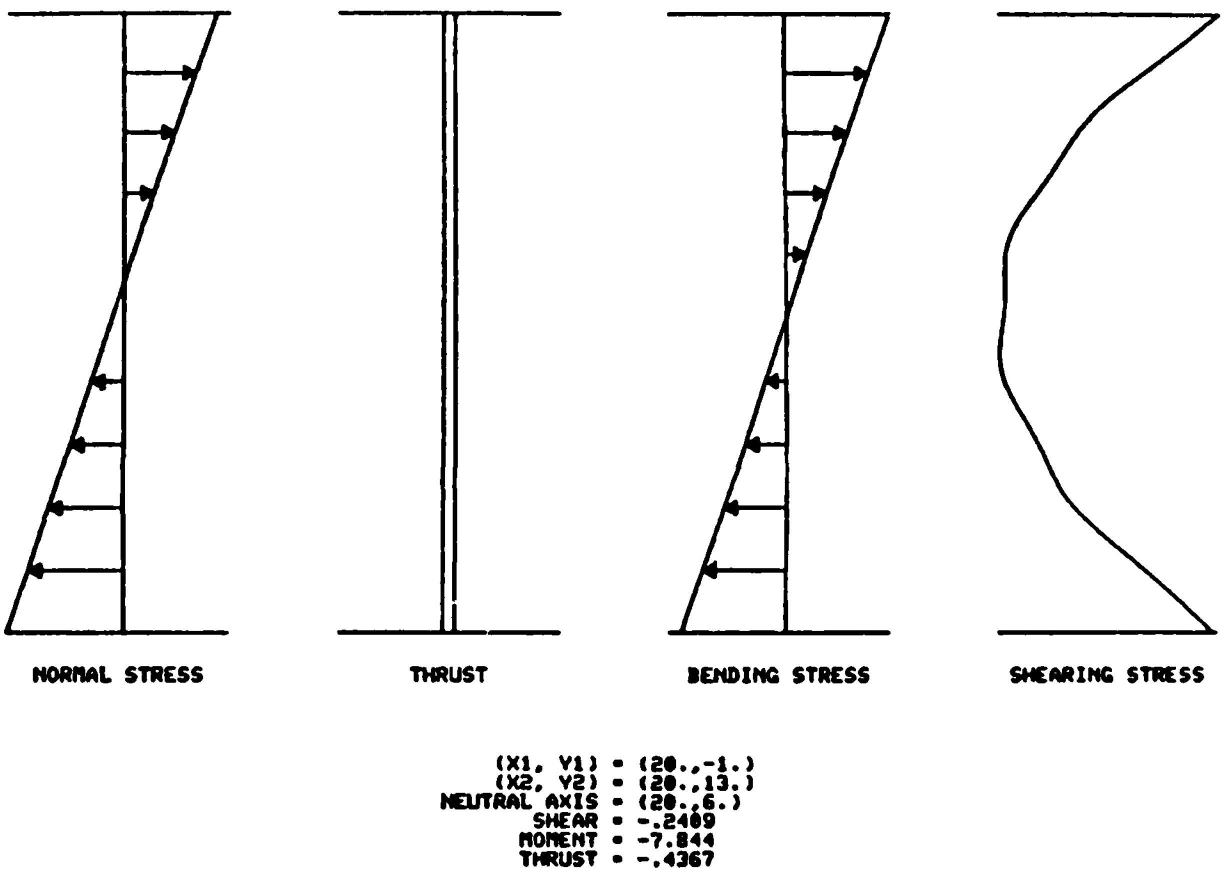
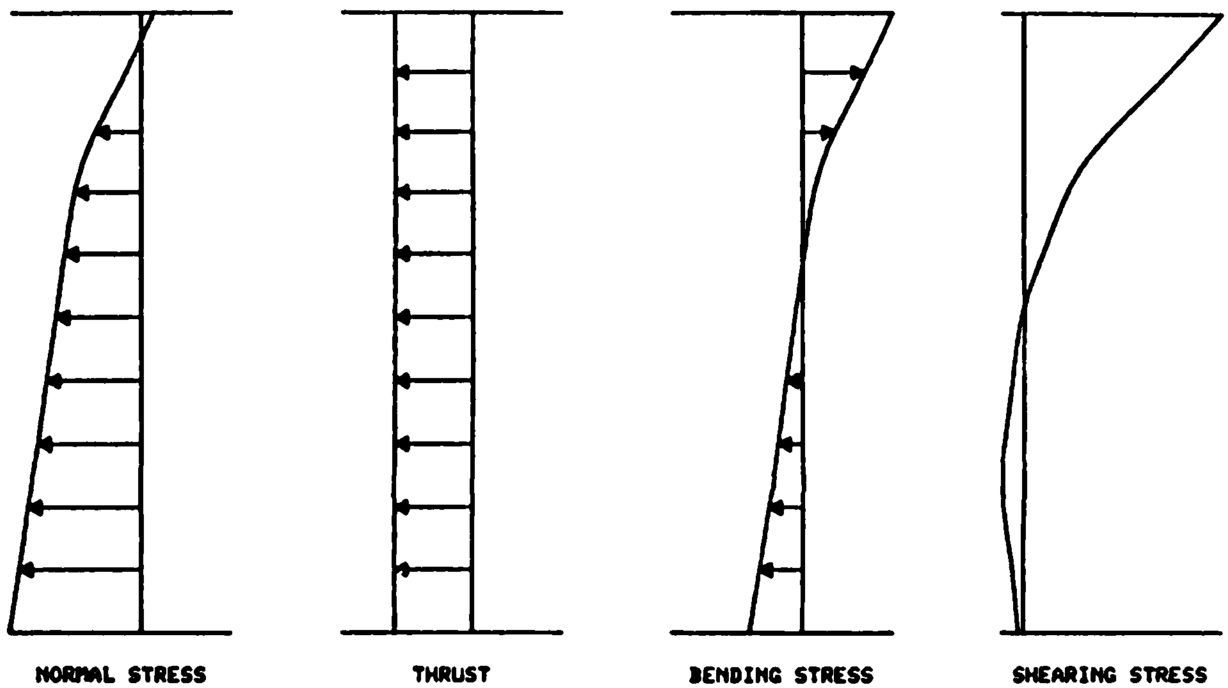
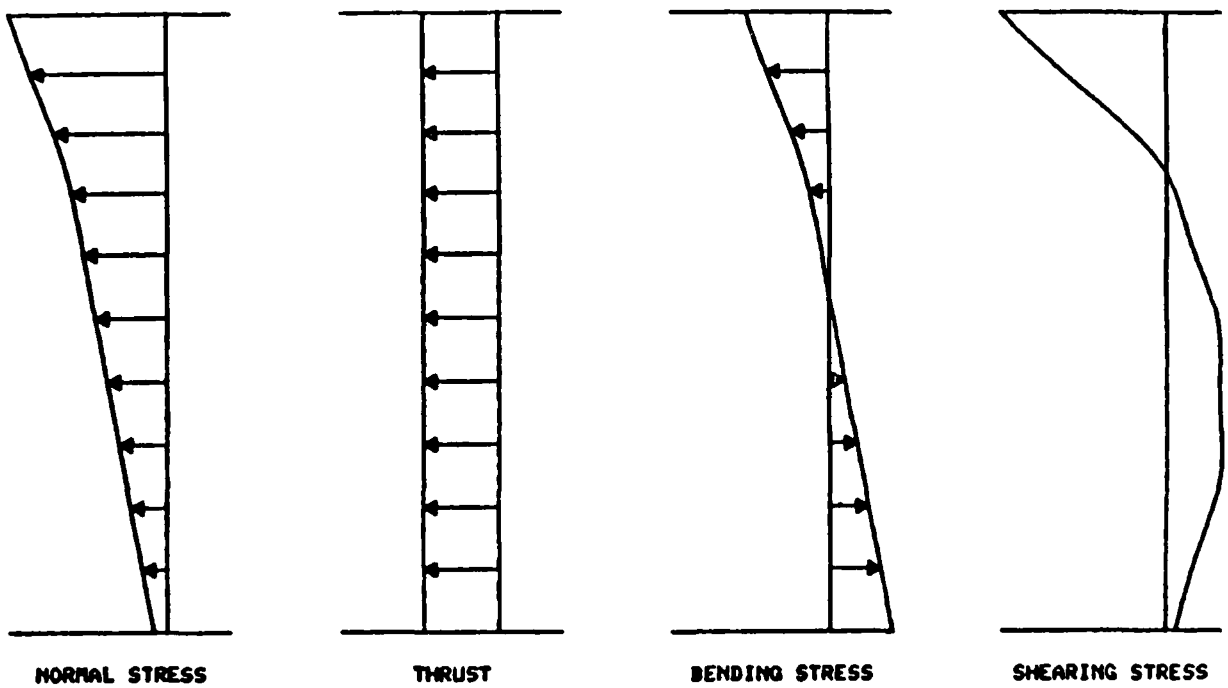


Figure A14. Load case 1B (section 14)



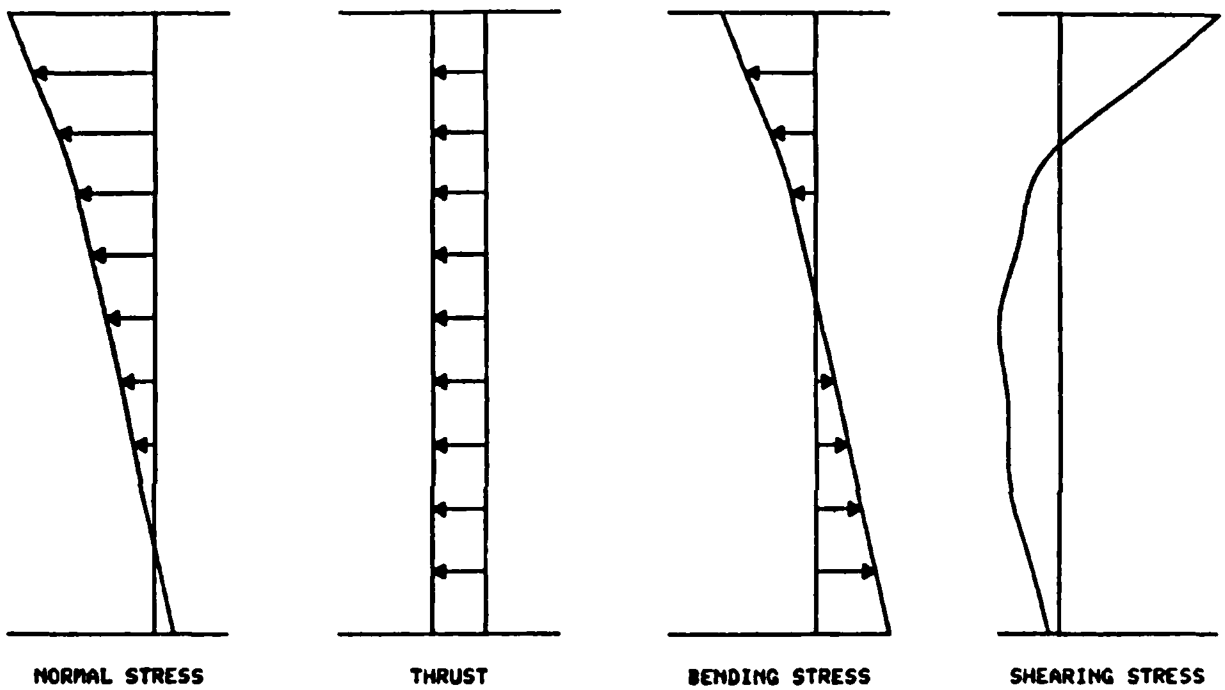
(X1, Y1) = (40.,32.)
(X2, Y2) = (53.,32.)
NEUTRAL AXIS = (47.85,32.)
SHEAR = .0237
MOMENT = -.4094
THRUST = -.3025

Figure A15. Load case 1B (section 15)



(X1, Y1) = (40.,53.)
(X2, Y2) = (48.,53.)
NEUTRAL AXIS = (44.67,53.)
SHEAR = .0006
MOMENT = .0877
THRUST = -.1158

Figure A16. Load case 1B (section 16)



(X1, Y1) = (40.,63.)
(X2, Y2) = (48.,63.)
NEUTRAL AXIS = (44.65,63.)
SHEAR = -.0037
MOMENT = .0853
THRUST = -.0686

Figure A17. Load case 1B (section 17)

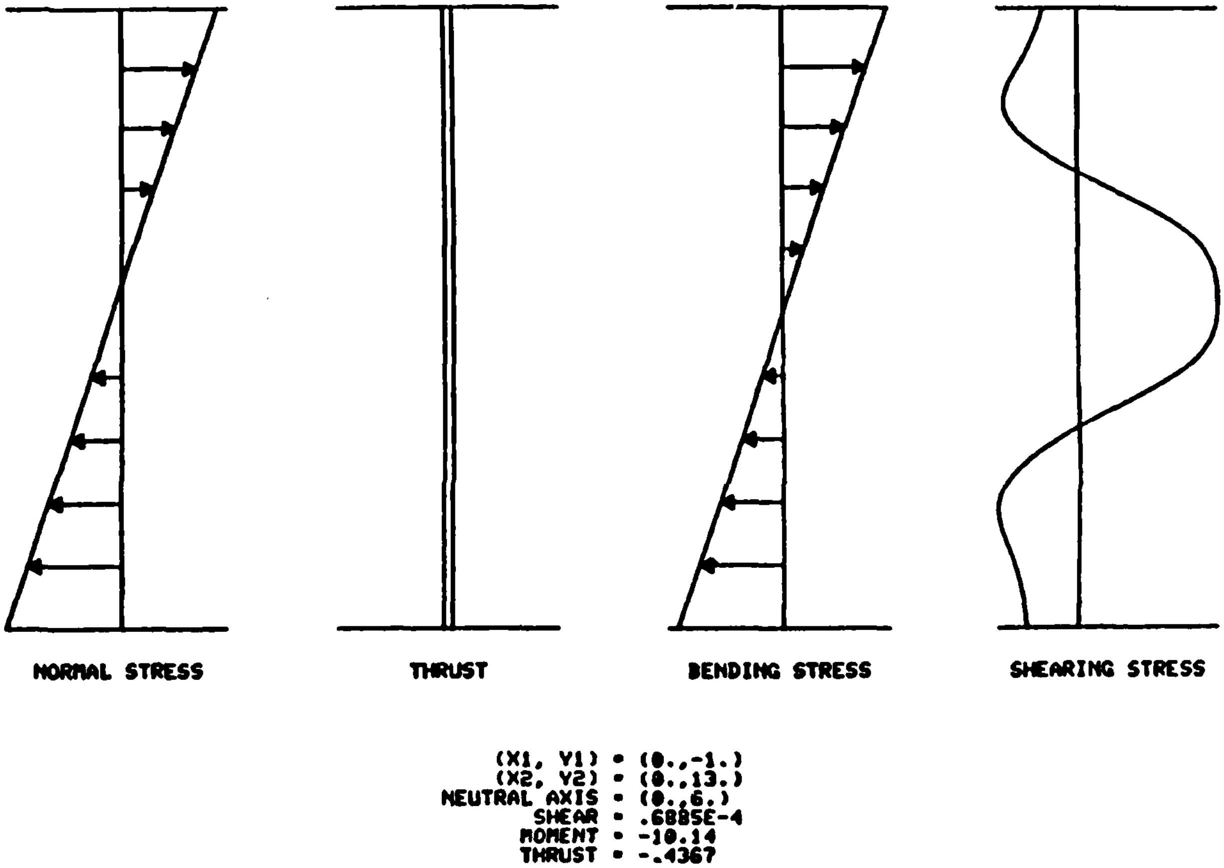
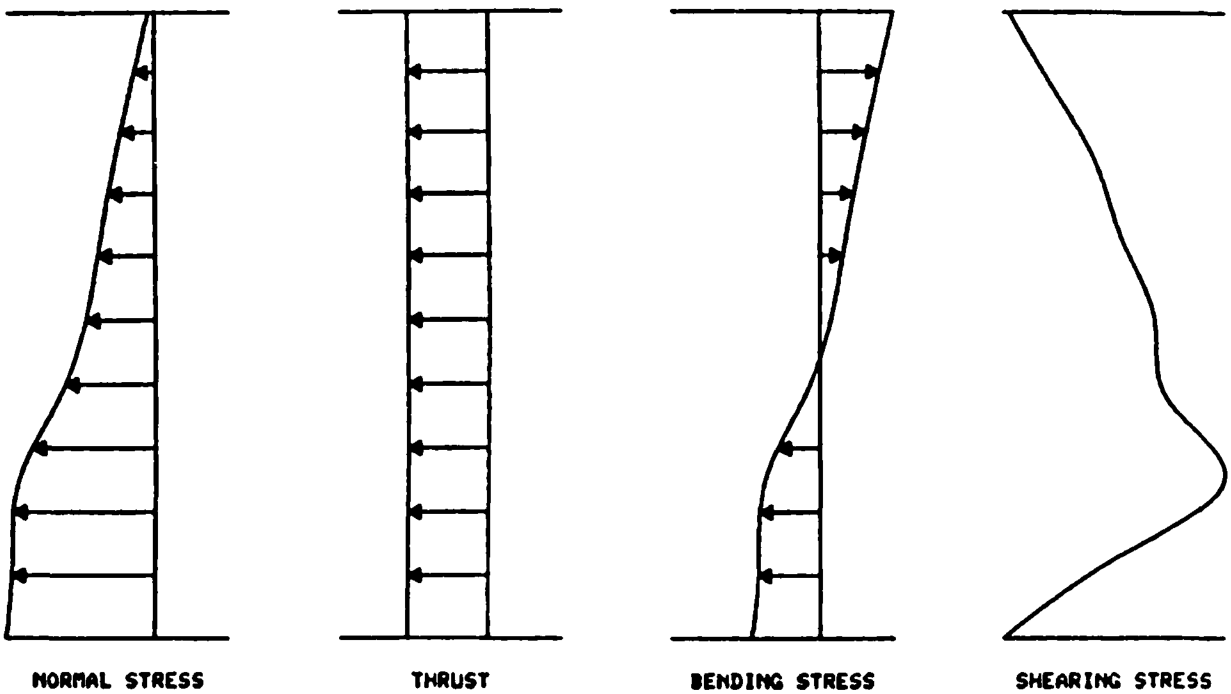
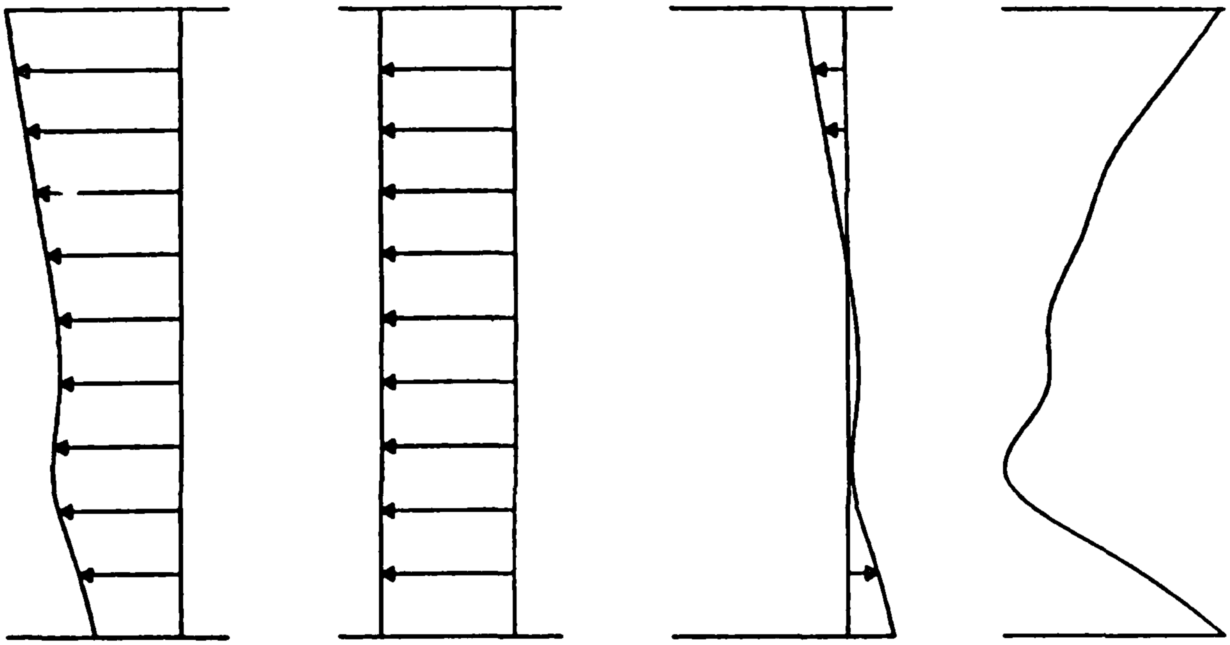


Figure A18. Load case 1B (section 18)



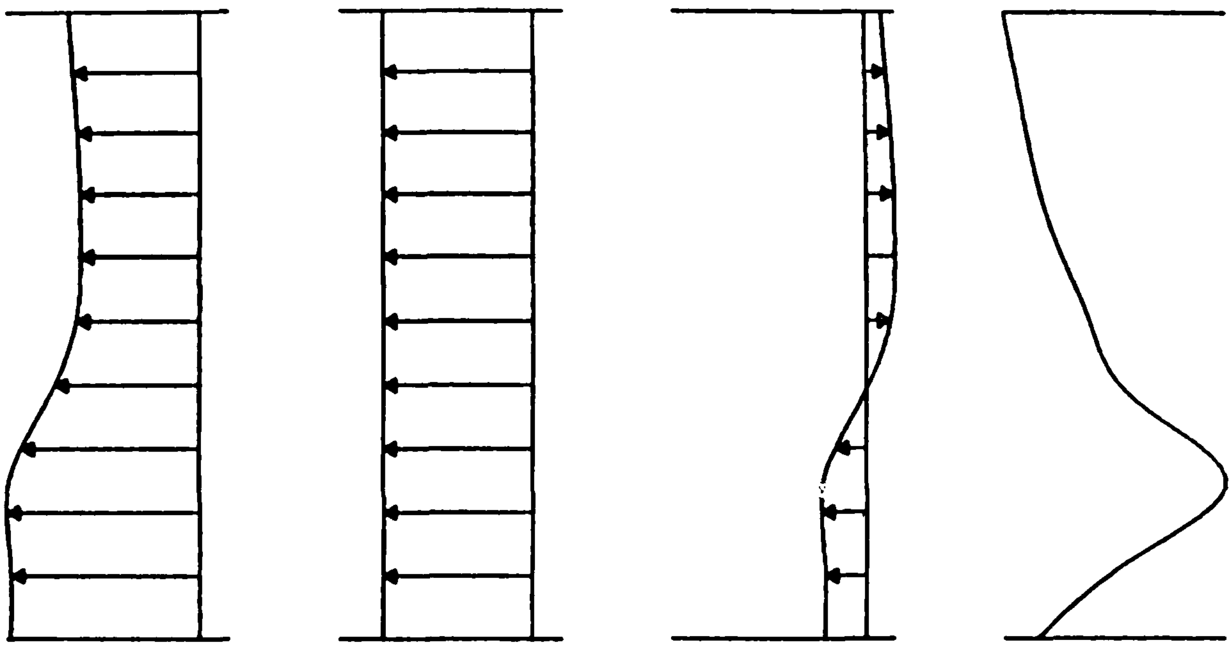
(X1, Y1) = (62.,11.)
(X2, Y2) = (70.,11.)
NEUTRAL AXIS = (65.81,11.)
SHEAR = .0878
MOMENT = -.1303
THRUST = -.1956

Figure A19. Load case 1B (section 1A)



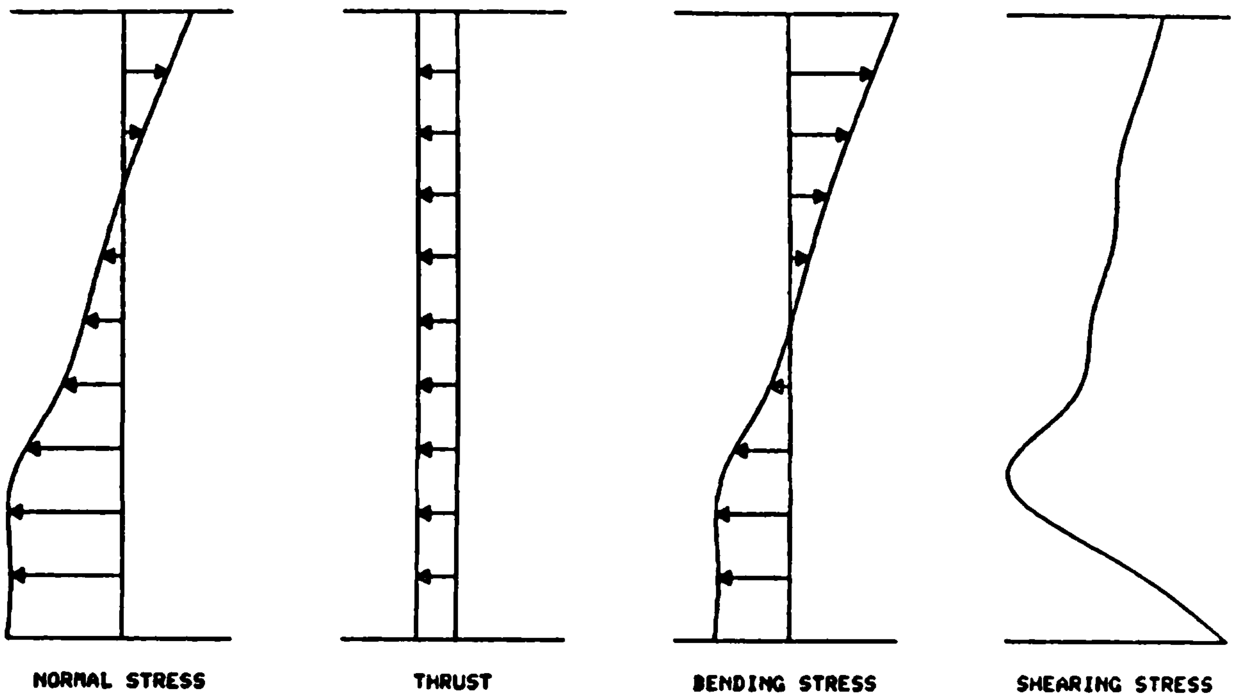
(X1, Y1) = (62.,21.)
(X2, Y2) = (70.,21.)
NEUTRAL AXIS = (66.33,21.)
SHEAR = -.0456
MOMENT = .0282
THRUST = -.1534

Figure A20. Load case 1B (section 2A)



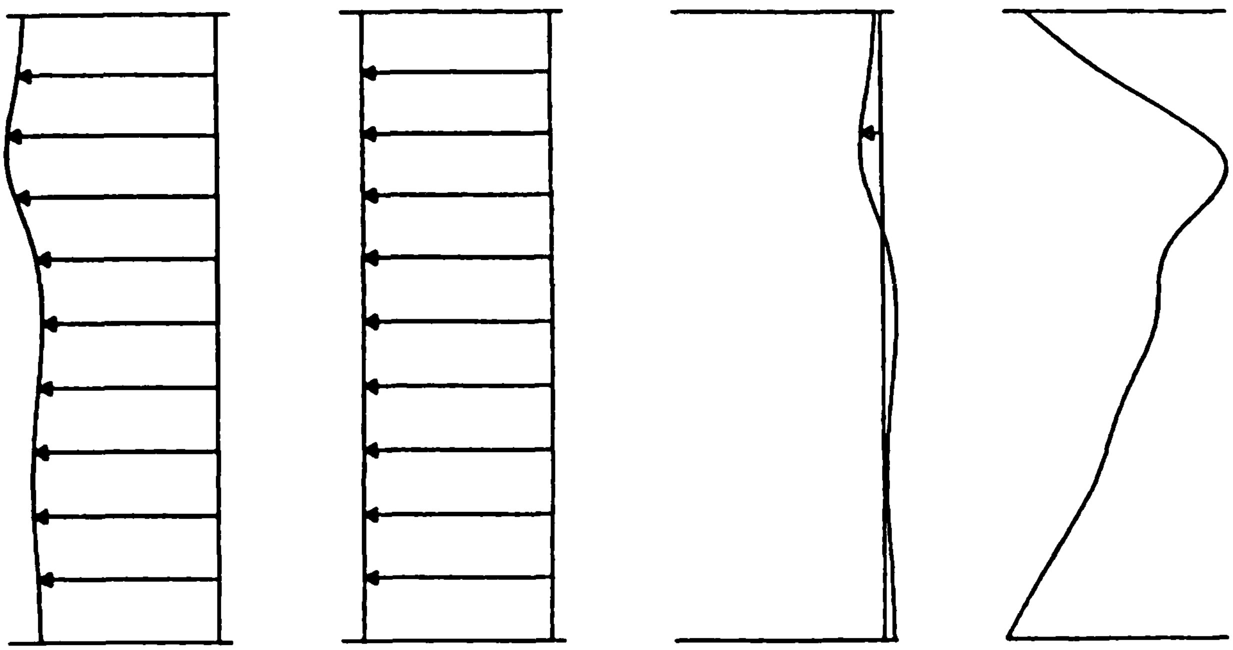
(X1, Y1) = (63.,20.)
(X2, Y2) = (63.,30.)
NEUTRAL AXIS = (63.,24.88)
SHEAR = .0461
MOMENT = -.0415
THRUST = -.1138

Figure A21. Load case 1B (section 3A)



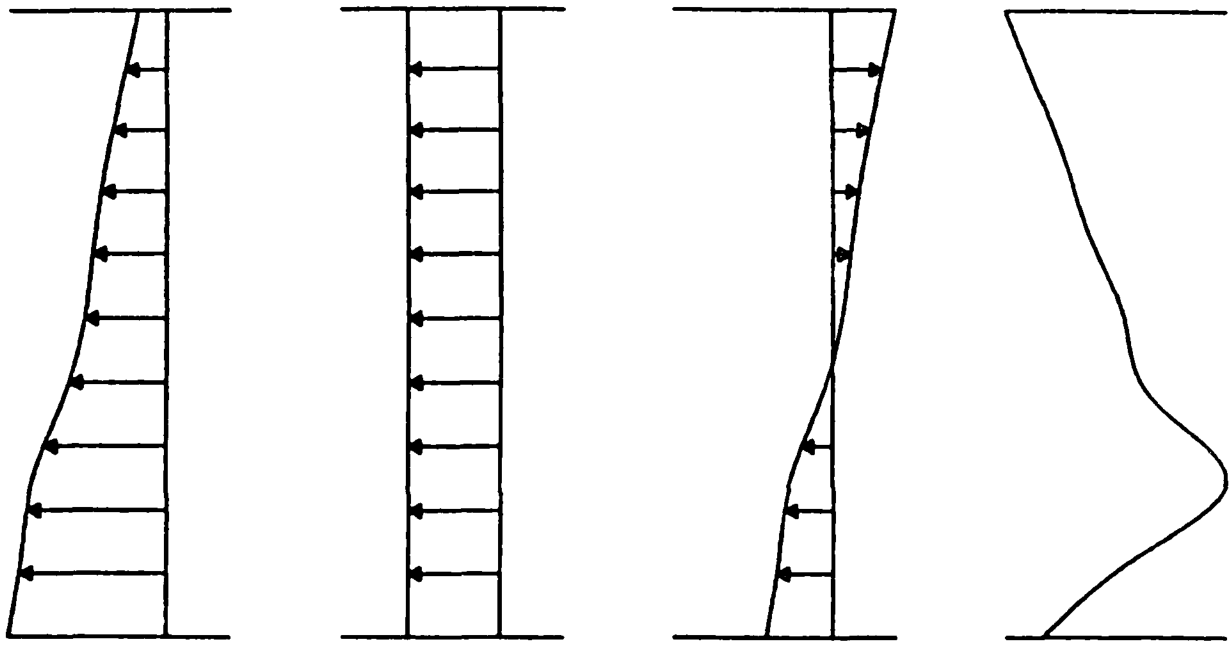
(X1, Y1) = (54.,20.)
(X2, Y2) = (54.,33.)
NEUTRAL AXIS = (54.,26.7)
SHEAR = -.1523
MOMENT = -.5497
THRUST = -.1375

Figure A22. Load case 1B (section 4A)



(X1, Y1) = (40.,20.)
(X2, Y2) = (54.,20.)
NEUTRAL AXIS = (48.41,20.)
SHEAR = .1708
MOMENT = .0718
THRUST = -.6061

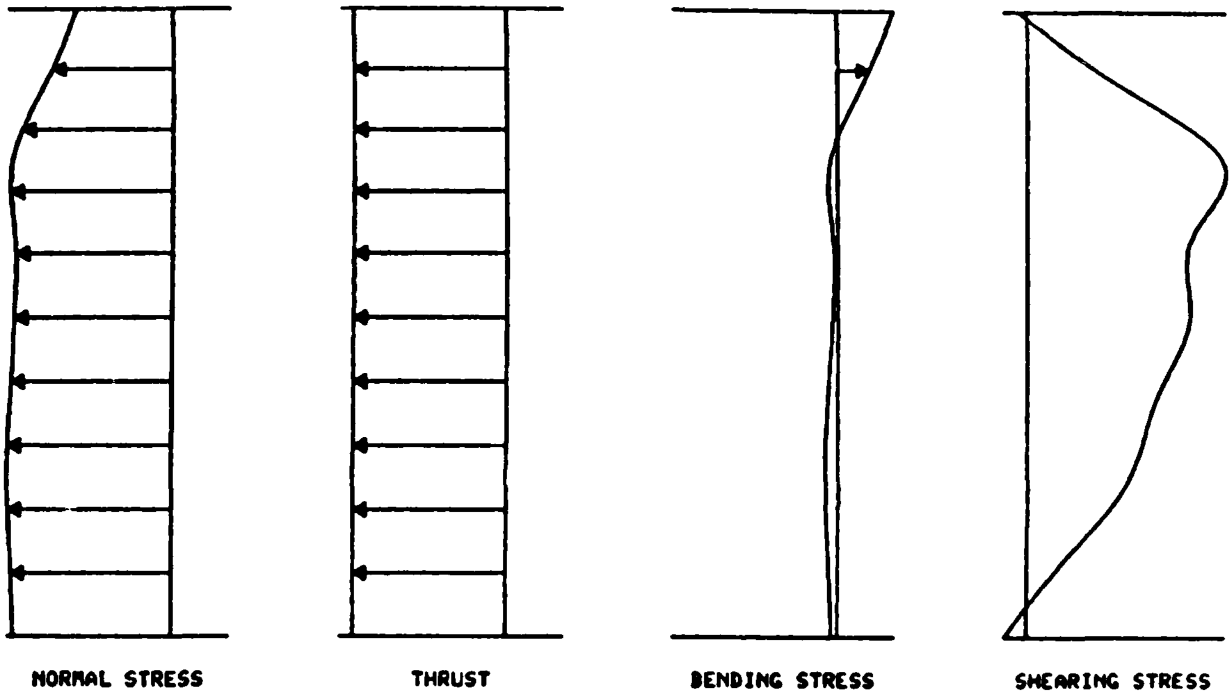
Figure A23. Load case 1B (section 5A)



NORMAL STRESS THRUST BENDING STRESS SHEARING STRESS

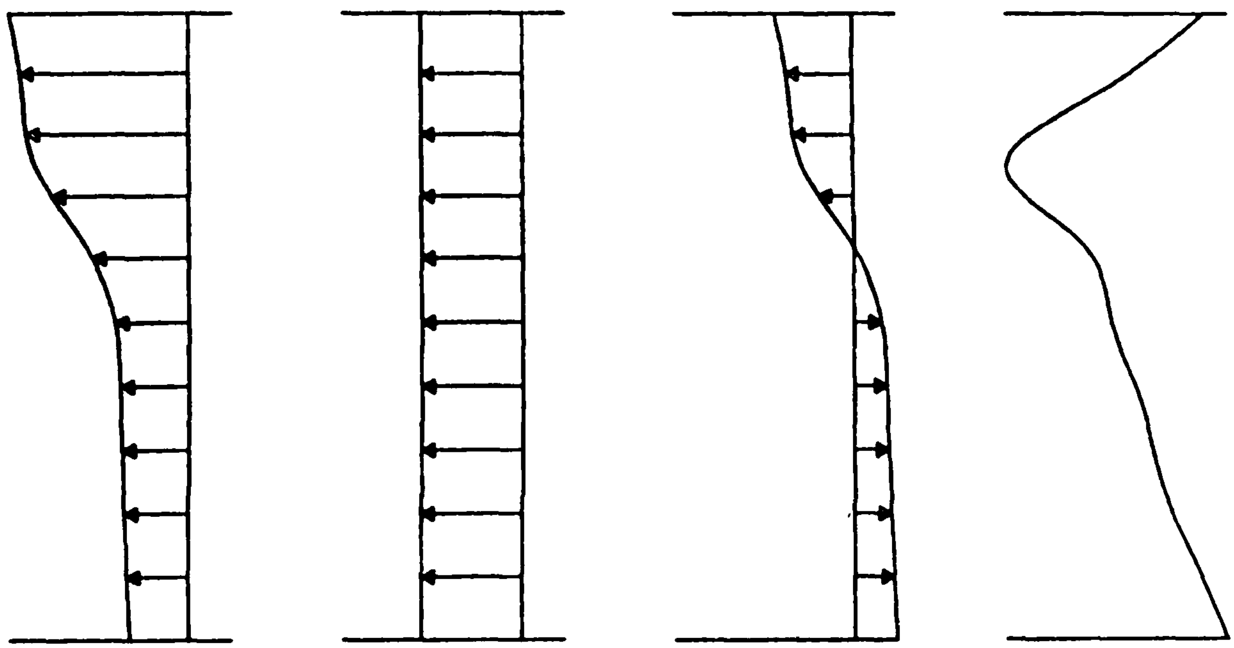
(X1, Y1) = (40.,14.)
(X2, Y2) = (54.,14.)
NEUTRAL AXIS = (46.43,14.)
SHEAR = .1726
MOMENT = -.8232
THRUST = -.6674

Figure A24. Load case 1B (section 6A)



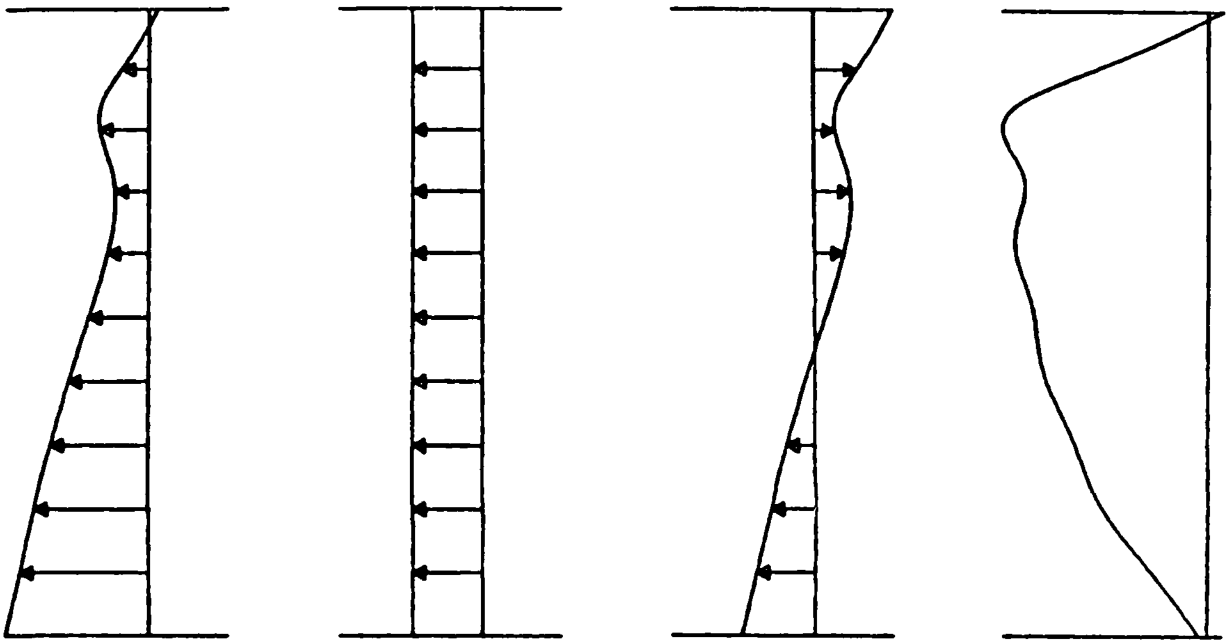
(X1, Y1) = (54.,1.)
(X2, Y2) = (54.,11.)
NEUTRAL AXIS = (54.,8.308)
SHEAR = .0493
MOMENT = -.0426
THRUST = -.2315

Figure A25. Load case 1B (section 7A)



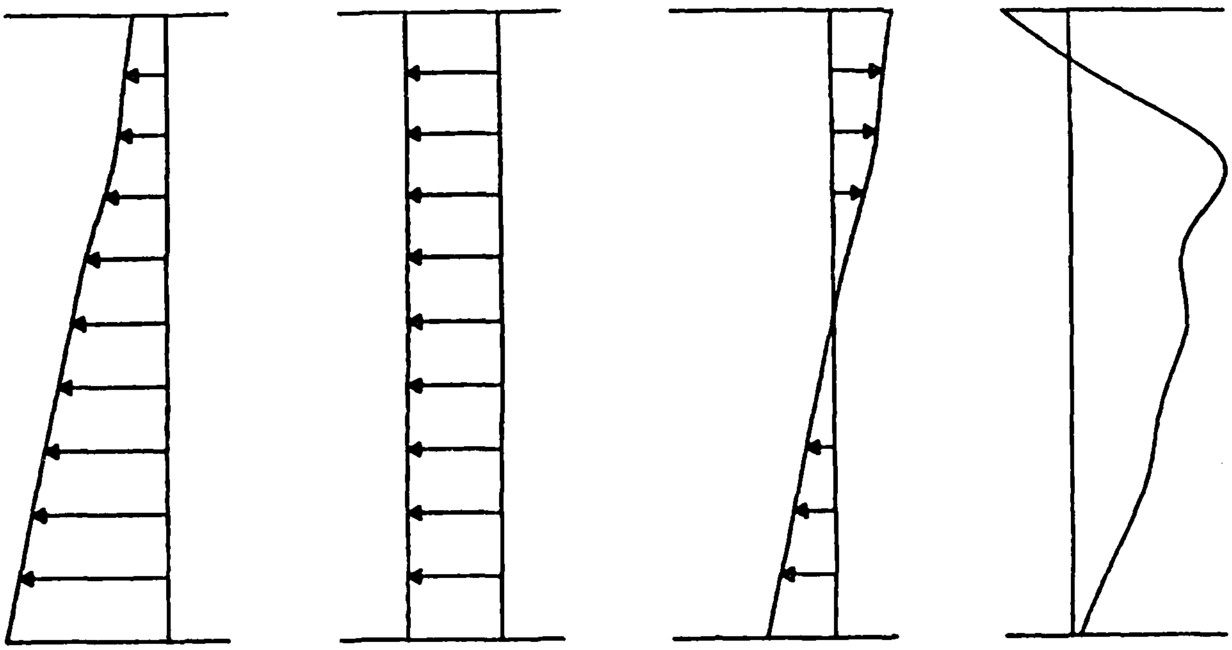
(X1, Y1) = (63.,3.)
(X2, Y2) = (63.,11.)
NEUTRAL AXIS = (63.,7.685)
SHEAR = -.1112
MOMENT = .1368
THRUST = -.1975

Figure A26. Load case 1B (section 8A)



(X1, Y1) = (40.,-1.)
(X2, Y2) = (40.,13.)
NEUTRAL AXIS = (40.,5.398)
SHEAR = -.4748
MOMENT = -.8707
THRUST = -.447

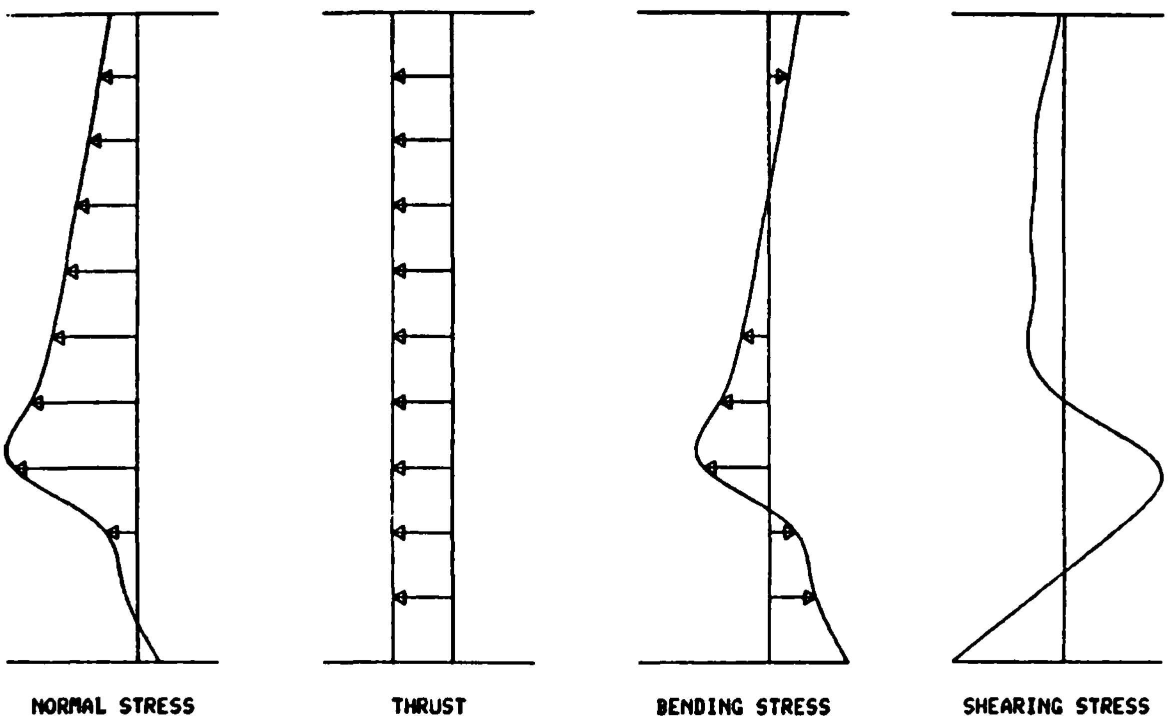
Figure A27. Load case 1B (section 9A)



NORMAL STRESS THRUST BENDING STRESS SHEARING STRESS

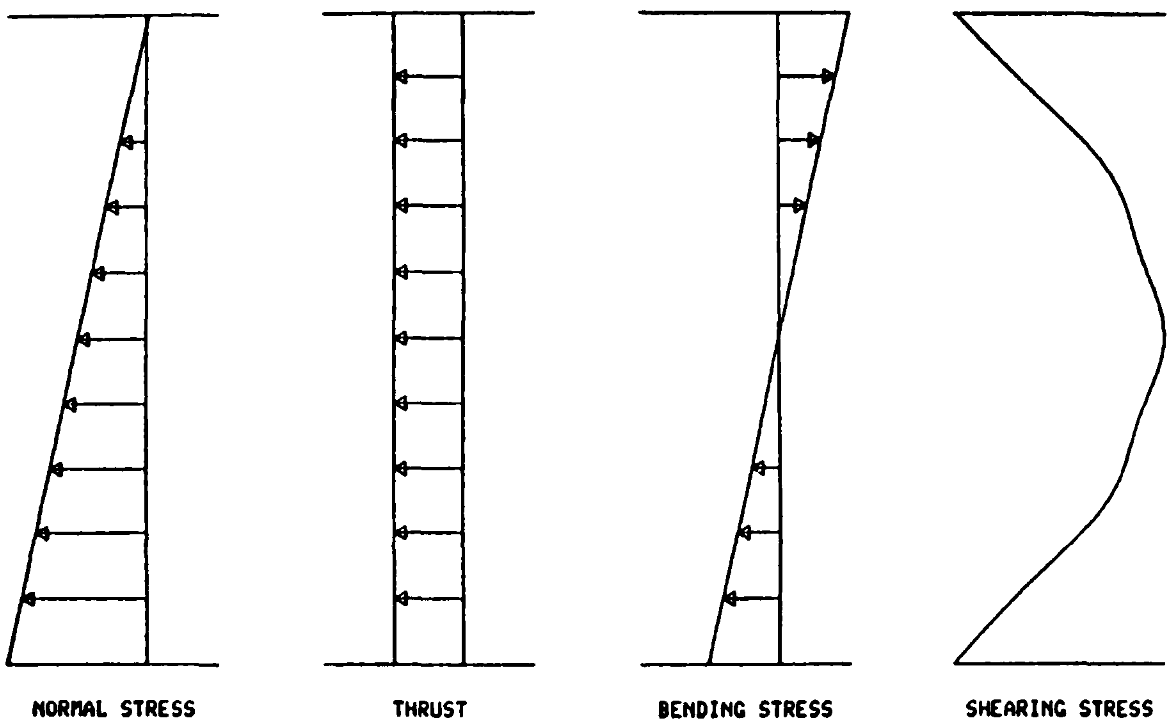
(X1, Y1) = (40.,36.)
(X2, Y2) = (52.,36.)
NEUTRAL AXIS = (46.58,36.)
SHEAR = .0158
MOMENT = -.2698
THRUST = -.2456

Figure A28. Load case 1B (section 10A)



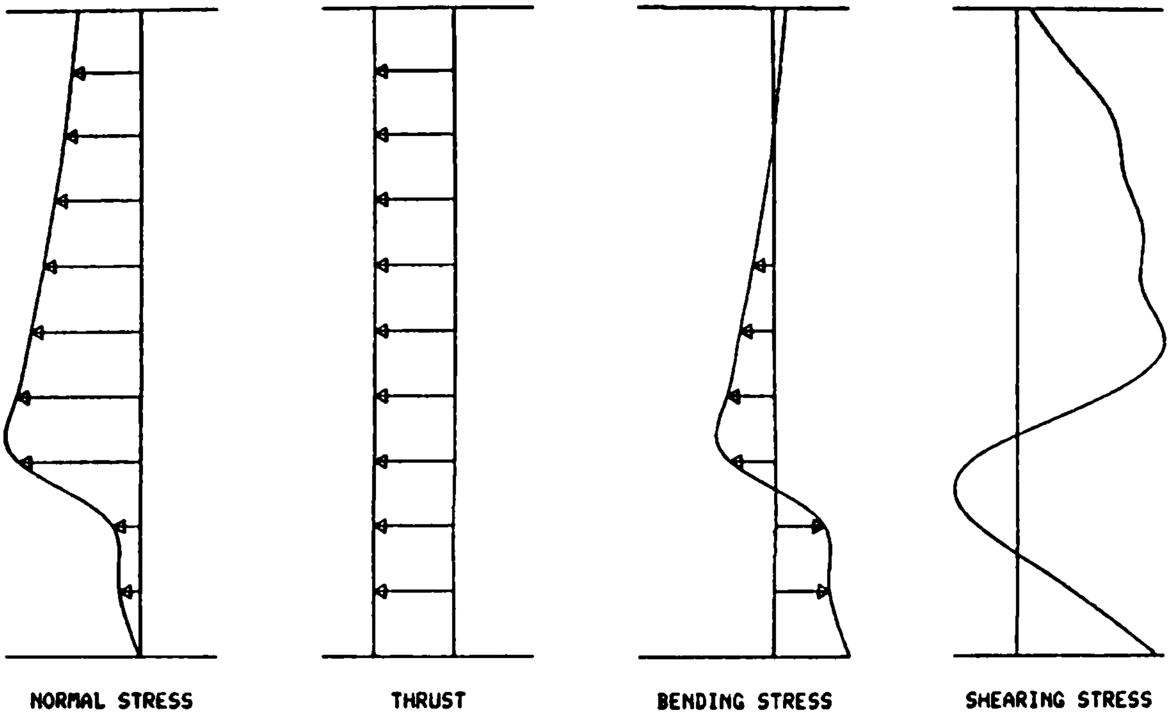
(X1, Y1) = (62 .10.)
(X2, Y2) = (70 .10.)
NEUTRAL AXIS = (66.4.10.)
SHEAR = - 0136
MOMENT = .0394
THRUST = -.3287

Figure A29. Load case 2B (section 1)



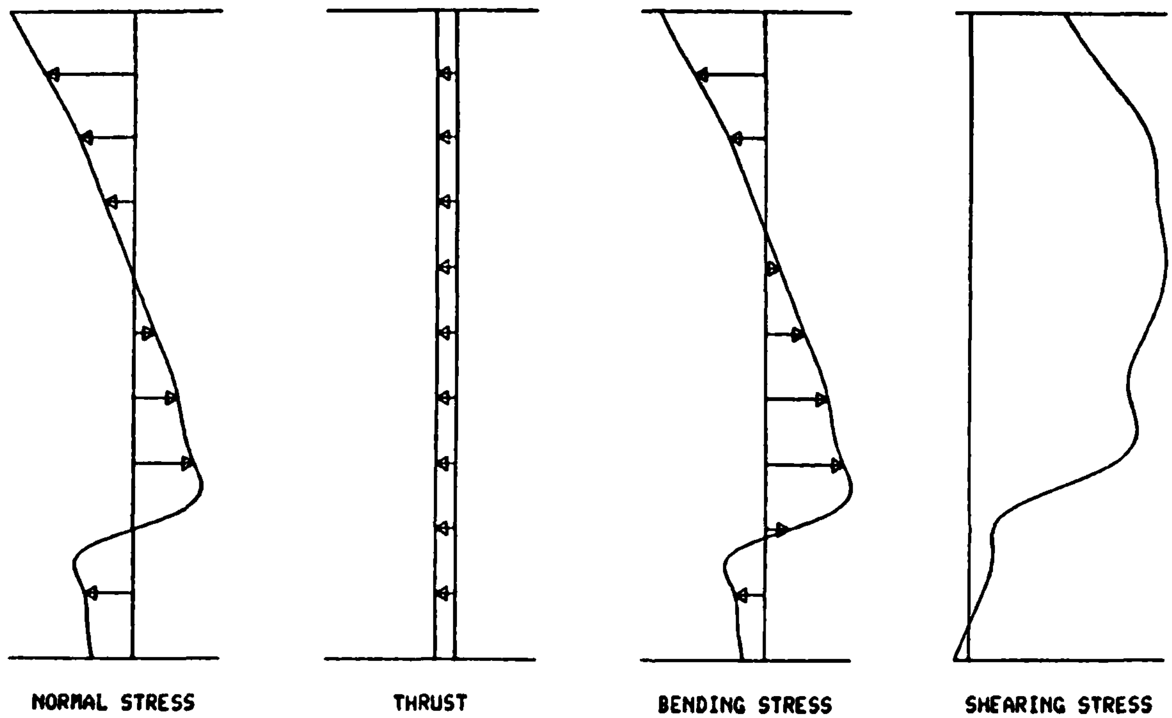
(X1, Y1) = (62 ,16)
(X2, Y2) = (70.,16.)
NEUTRAL AXIS = (66 ,16)
SHEAR = 0051
MOMENT = -.1791
THRUST = -.2598

Figure A30. Load case 2B (section 2)



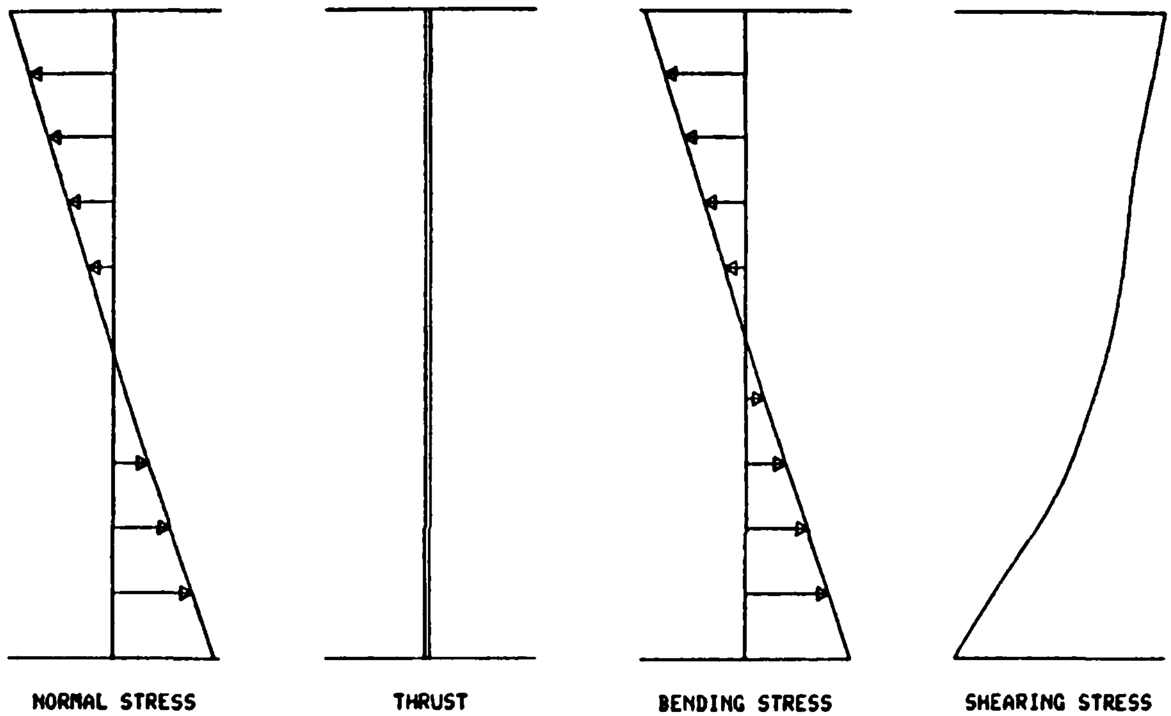
(X1, Y1) = (62 .22)
(X2, Y2) = (70 .22)
NEUTRAL AXIS = (66 89.22.)
SHEAR = 0403
MOMENT = .0824
THRUST = - 2714

Figure A31. Load case 2B (section 3)



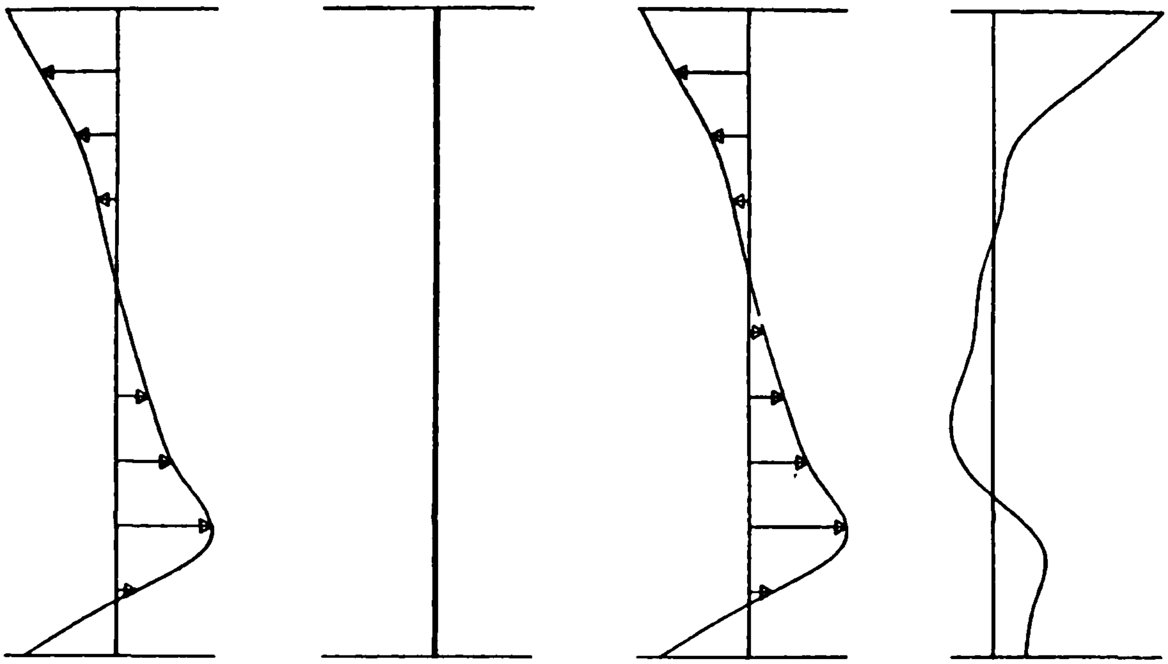
(X1, Y1) = (64.,20.)
(X2, Y2) = (64.,30.)
NEUTRAL AXIS = (64.,25.91)
SHEAR = 1499
MOMENT = 2424
THRUST = -.068

Figure A32. Load case 2B (section 4)



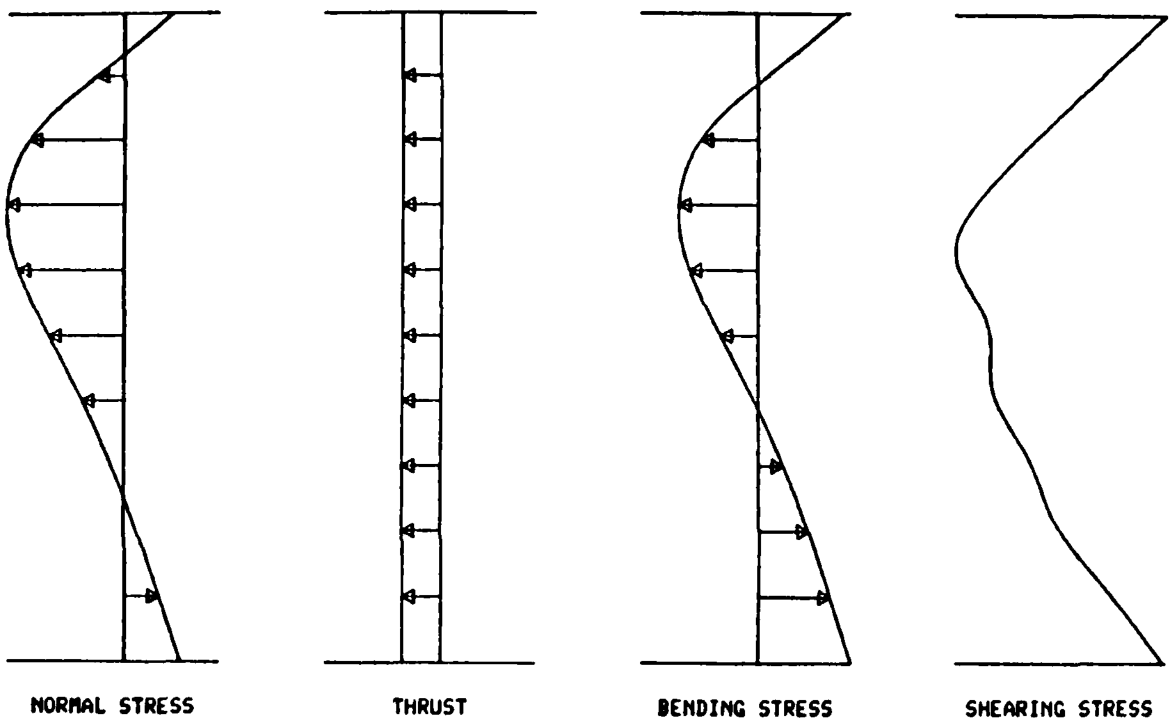
(X1, Y1) = (58 .20)
(X2, Y2) = (58 .32)
NEUTRAL AXIS = (58 .26.18)
SHEAR = .1322
MOMENT = 1 185
THRUST = - 0381

Figure A33. Load case 2B (section 5)



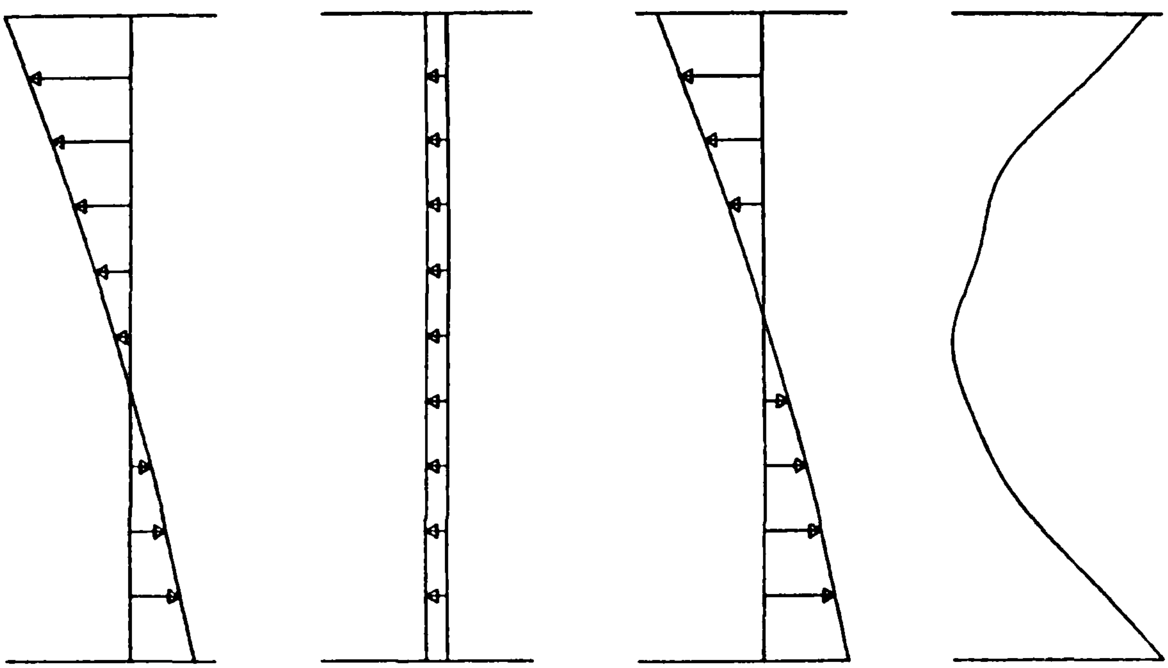
(X1, Y1) = (52 .20)
(X2, Y2) = (52 .33)
NEUTRAL AXIS = (52 .27.03)
SHEAR = .1064
MOMENT = 1 562
THRUST = - 0339

Figure A34. Load case 2B (section 6)



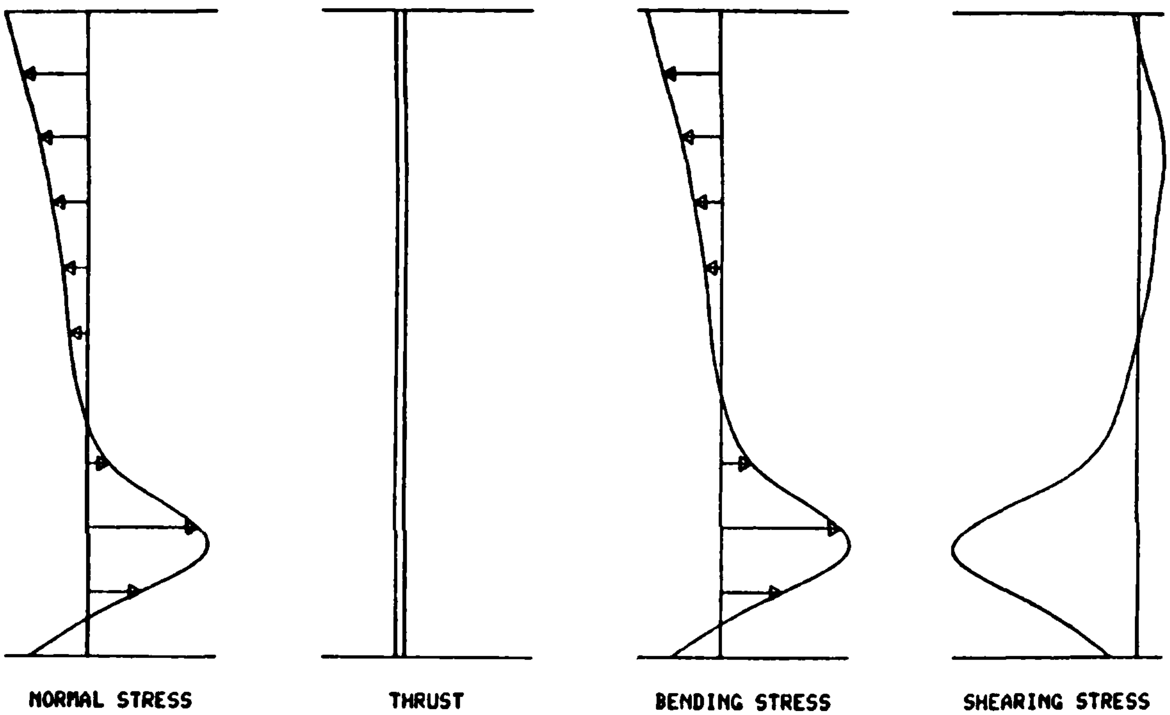
(X1, Y1) = (40.,22)
(X2, Y2) = (54 .22)
NEUTRAL AXIS = (52 63.22)
SHEAR = -.2677
MOMENT = 8072
THRUST = -.2941

Figure A35. Load case 2B (section 7)



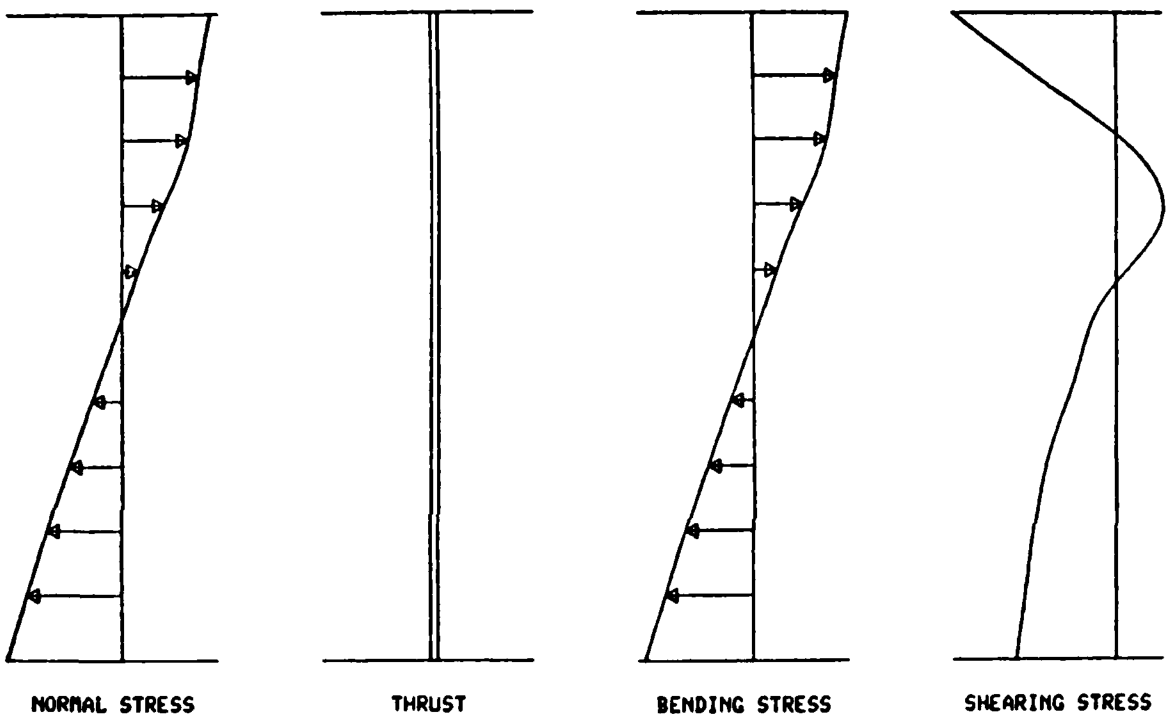
(X1, Y1) = (40.,17.)
(X2, Y2) = (54.,17.)
NEUTRAL AXIS = (47.29,17.)
SHEAR = -.2722
MOMENT = 2.413
THRUST = -.3198

Figure A36. Load case 2B (section 8)



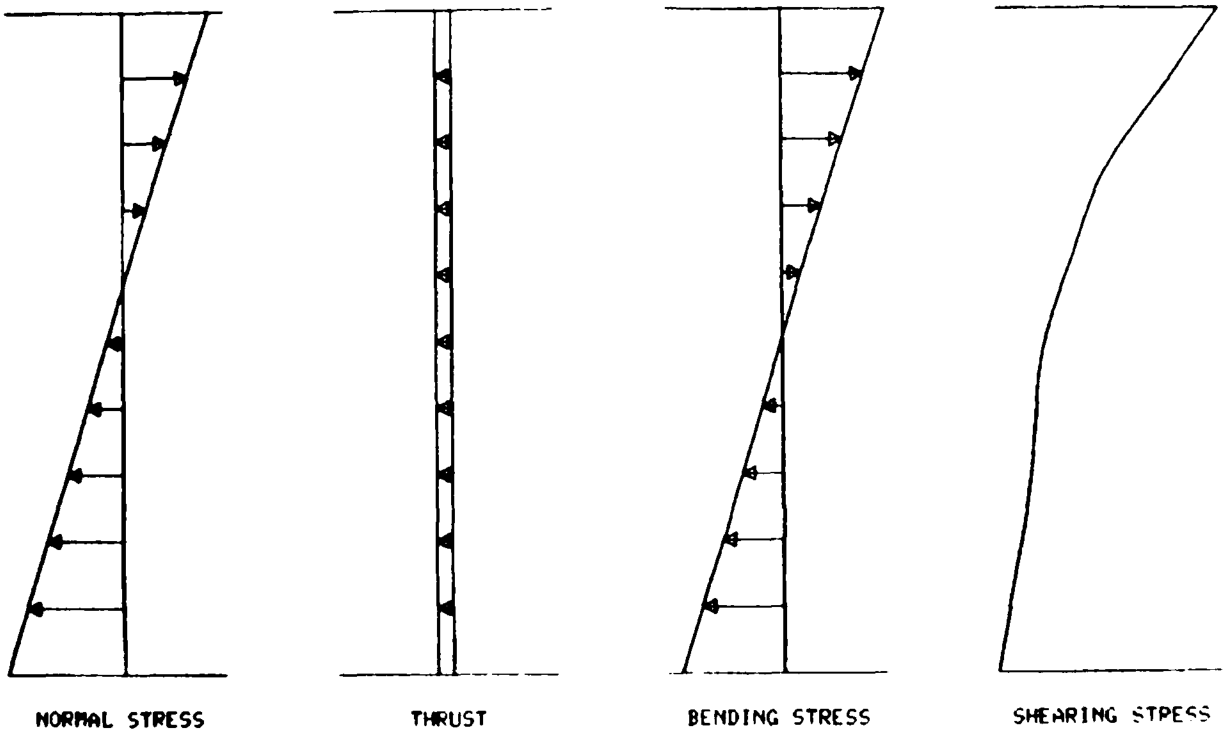
(X1, Y1) = (40 .12)
(X2, Y2) = (54 .12)
NEUTRAL AXIS = (45 01.12.)
SHEAR = - 405
MOMENT = 4 334
THRUST = - 2807

Figure A37. Load case 2B (section 9)



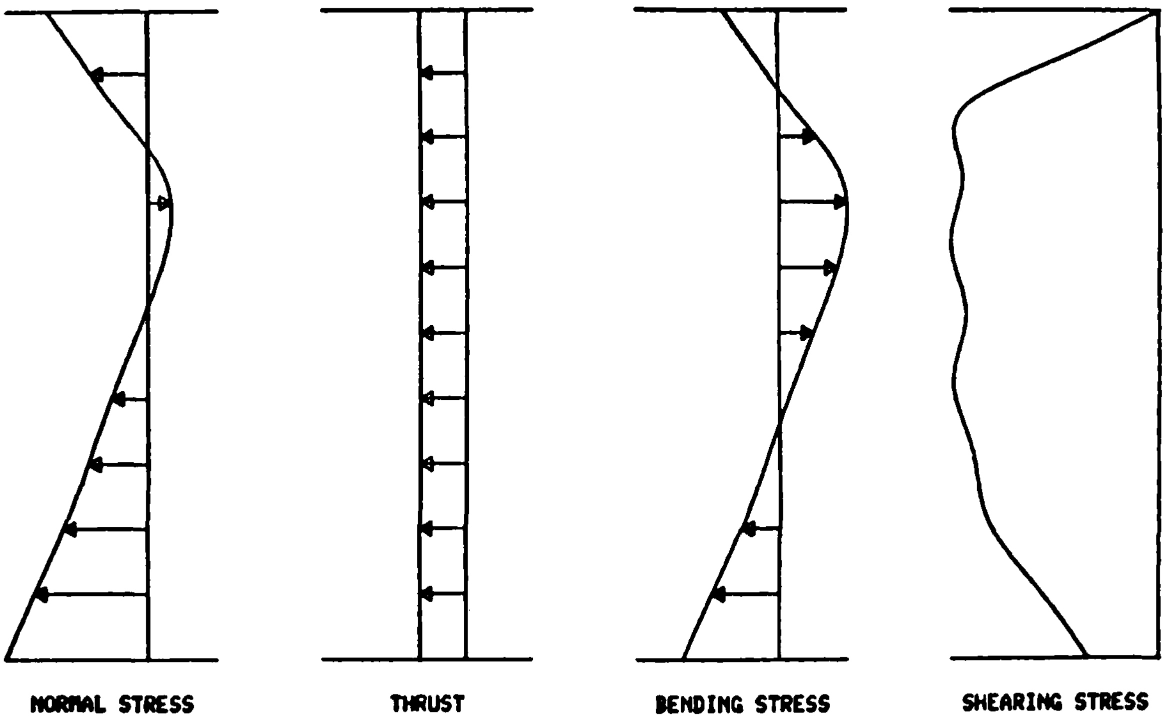
(X1, Y1) = (52 .1)
(X2, Y2) = (52 .11)
NEUTRAL AXIS = (52 .6 438)
SHEAR = - 1059
MOMENT = -2 025
THRUST = - 0865

Figure A38. Load case 2B (section 10)



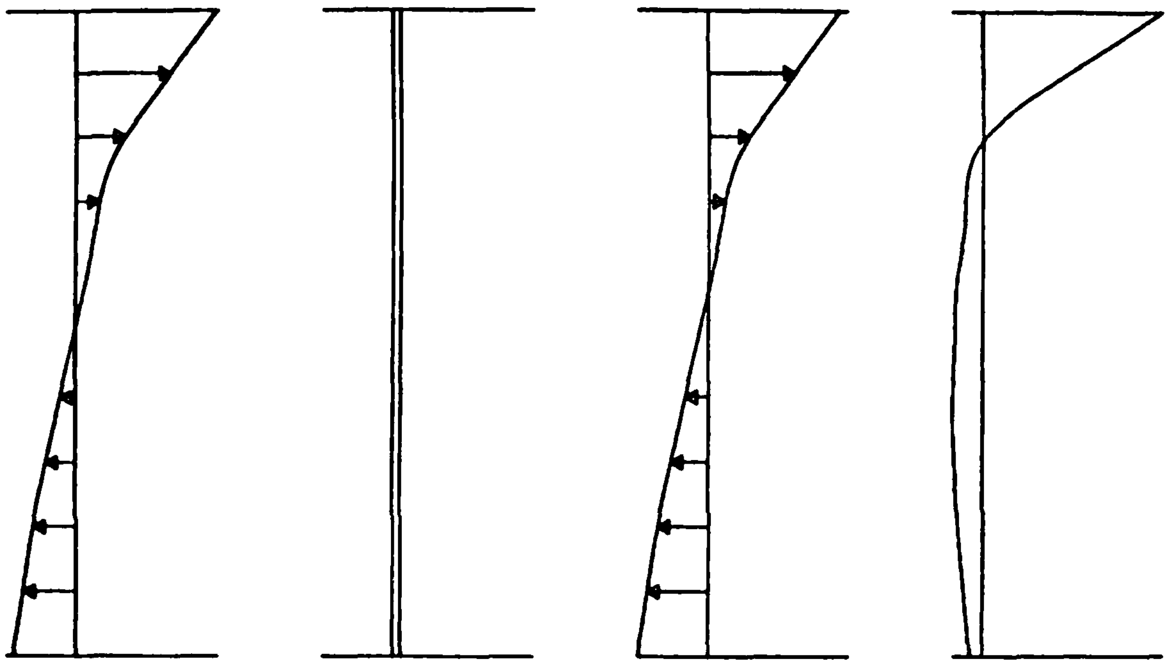
(X1, Y1) = (58 ,2)
(X2, Y2) = (58 .11)
NEUTRAL AXIS = (58 .6 557)
SHEAR = - 1118
MOMENT = -1 04
THRUST = - 142

Figure A39. Load case 2B (section 11)



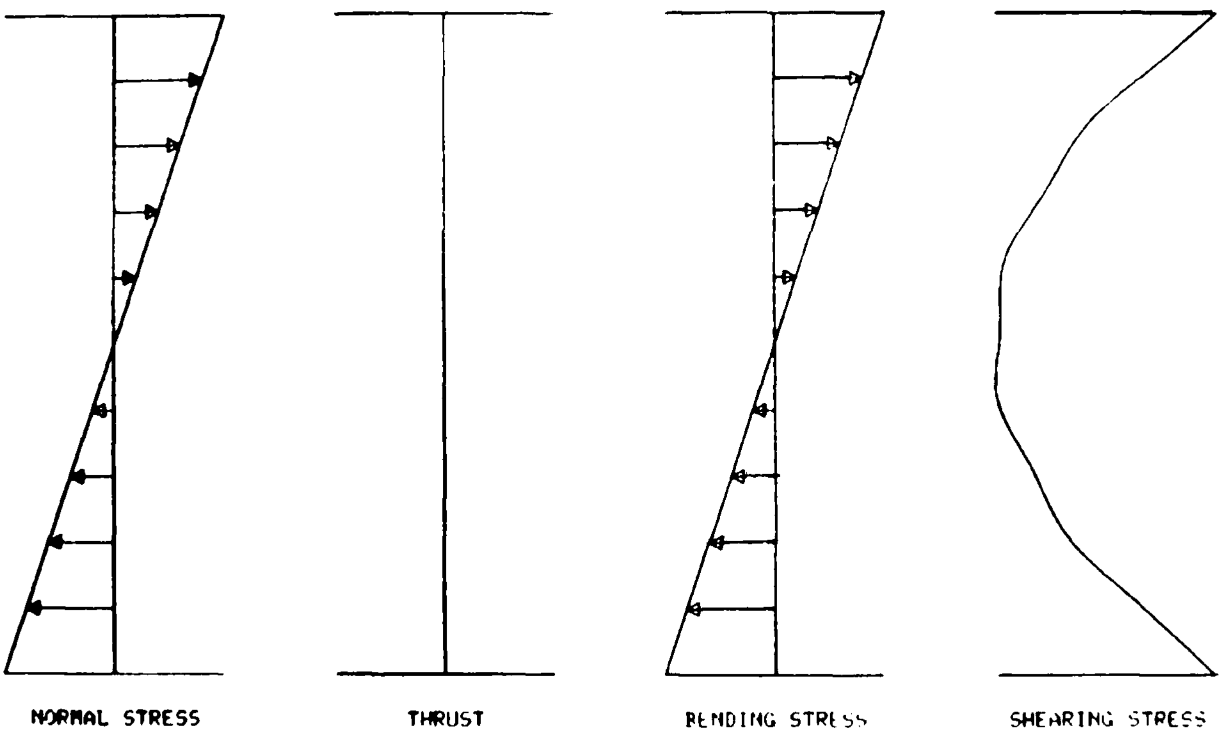
(X1, Y1) = (64.,3.)
(X2, Y2) = (64.,11.)
NEUTRAL AXIS = (64.,10.15)
SHEAR = -.1668
MOMENT = -.1692
THRUST = -.1493

Figure A40. Load case 2B (section 12)



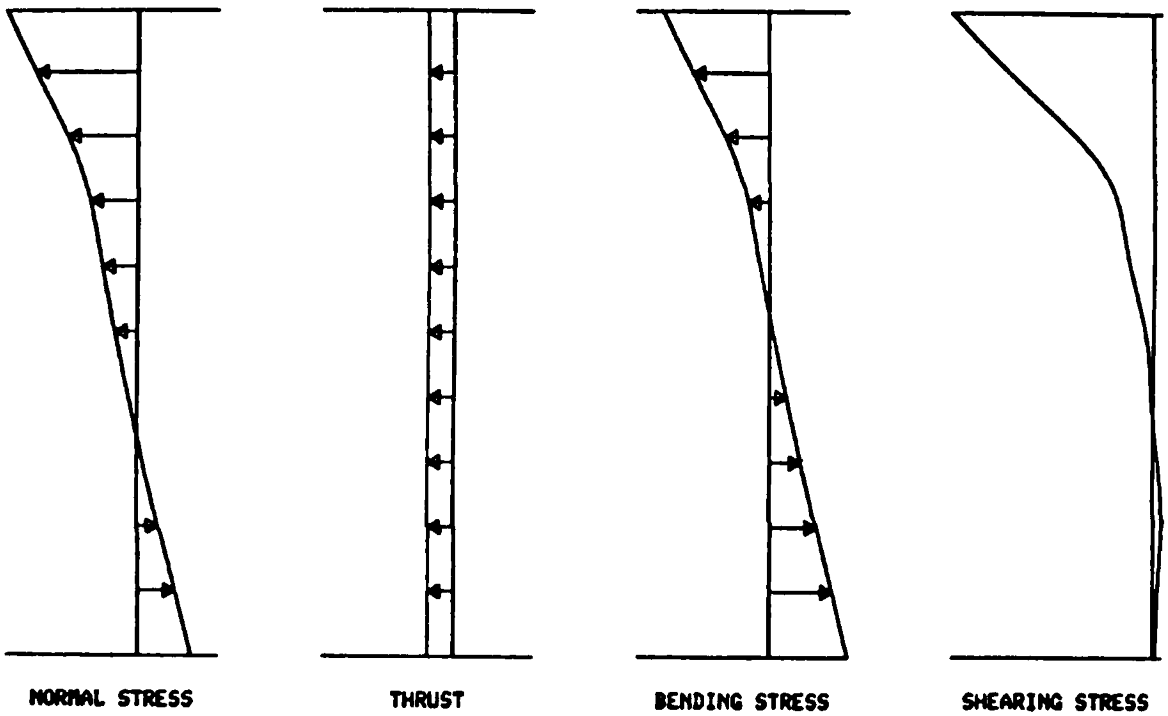
(X1, Y1) = (42.,-1.)
(X2, Y2) = (42.,13.)
NEUTRAL AXIS = (42.,7.31)
SHEAR = -.0111
MOMENT = -10.89
THRUST = .4203

Figure A41. Load case 2B (section 13)



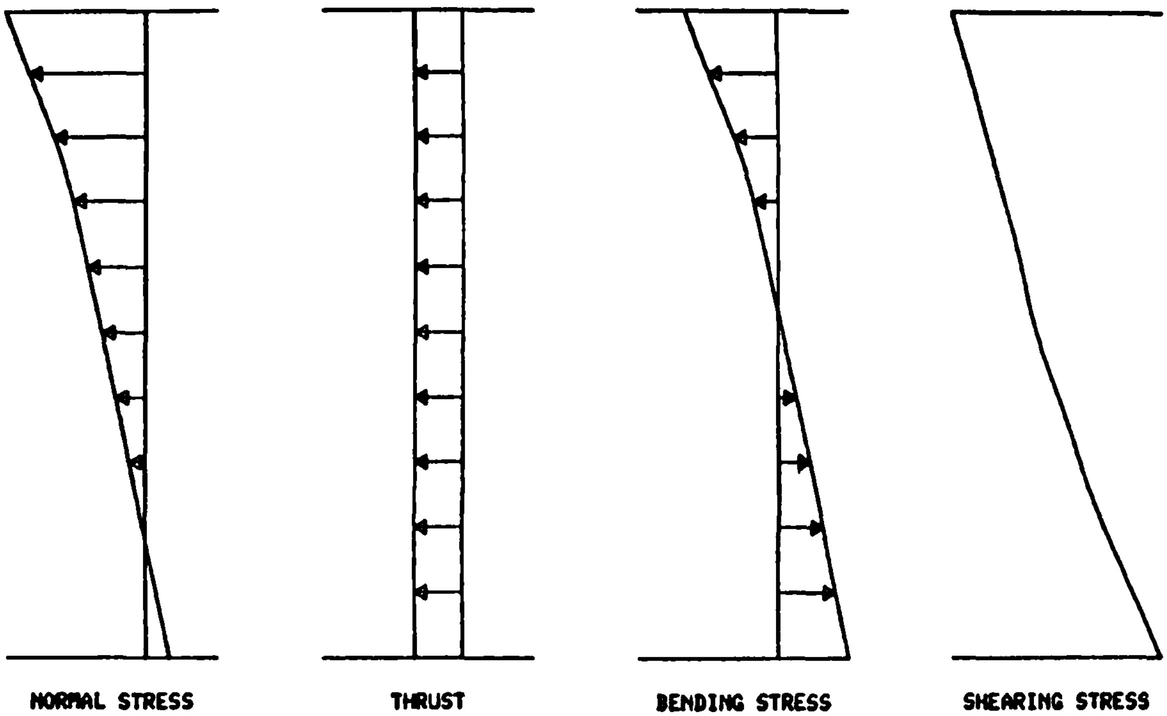
(X1, Y1) = (20, -1)
(X2, Y2) = (20, 13)
NEUTRAL AXIS = (20, 6)
SHEAR = -.0931
MOMENT = -11.23
THRUST = -.0003

Figure A42. Load case 2B (section 14)



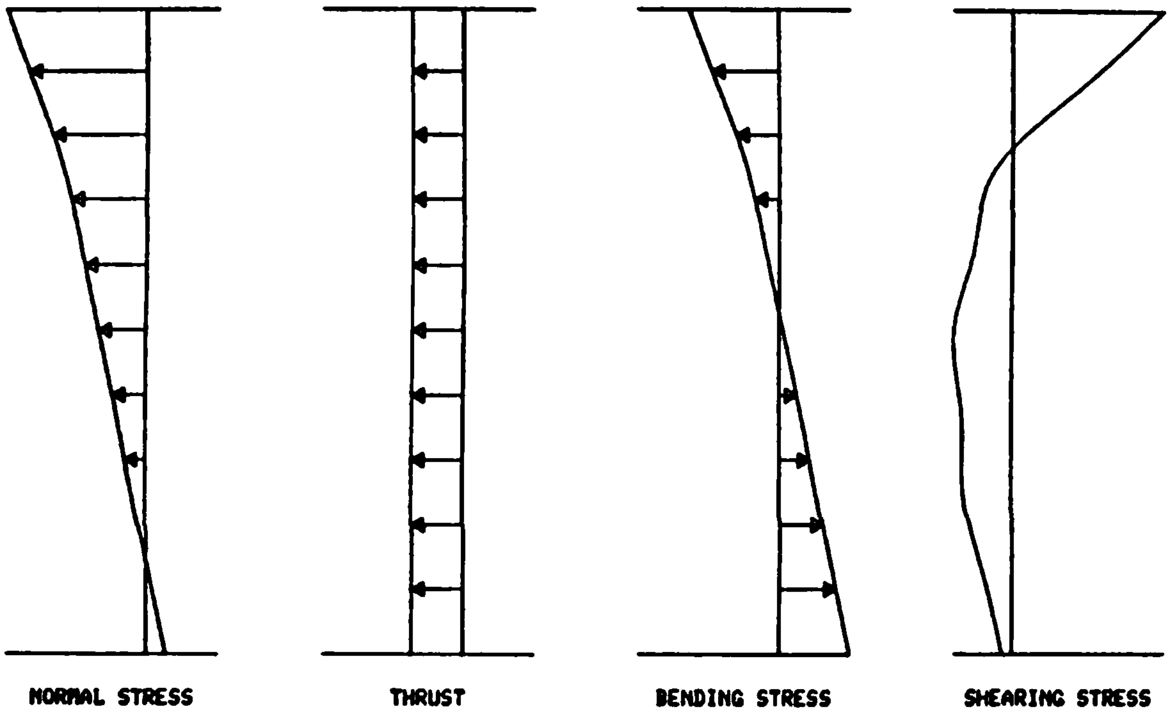
(X1, Y1) = (40.,32.)
(X2, Y2) = (53.,32.)
NEUTRAL AXIS = (47.3,32.)
SHEAR = -.1131
MOMENT = 1.42
THRUST = -.2629

Figure A43. Load case 2B (section 15)



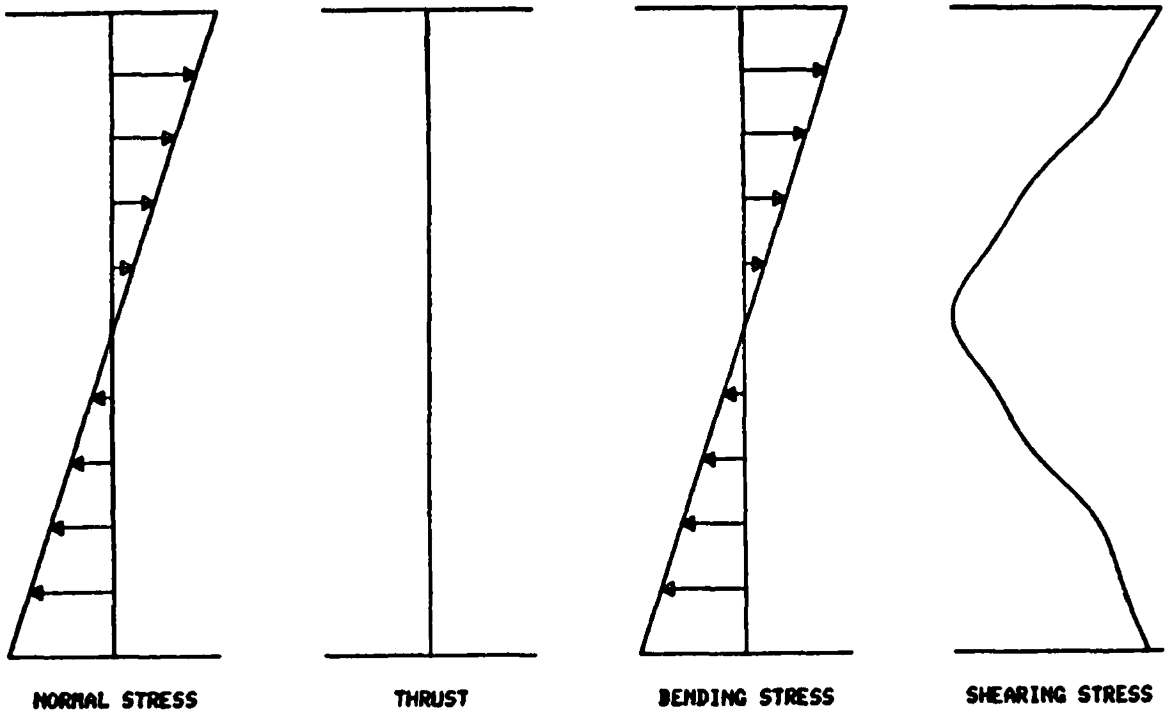
(X1, Y1) = (40.,53.)
(X2, Y2) = (48.,53.)
NEUTRAL AXIS = (44.66,53.)
SHEAR = -.0225
MOMENT = .1581
THRUST = -.1156

Figure A44. Load case 2B (section 16)



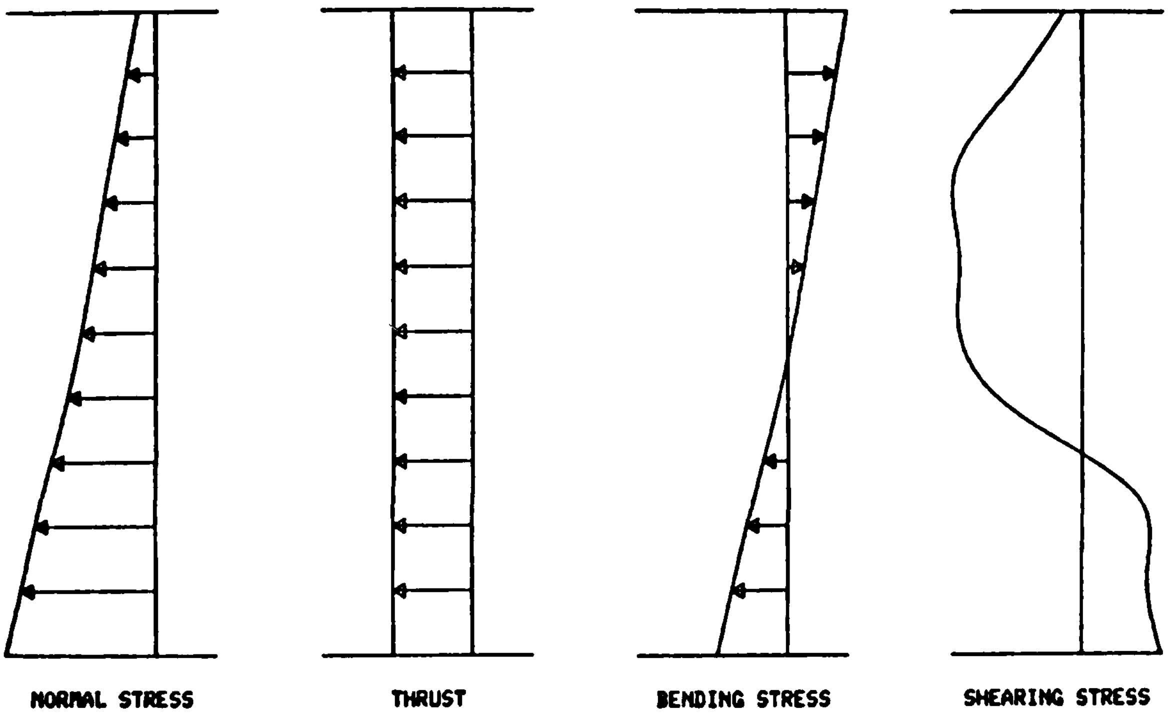
(X1, Y1) = (40.,63.)
(X2, Y2) = (48.,63.)
NEUTRAL AXIS = (44.64,63.)
SHEAR = -.0036
MOMENT = .085
THRUST = -.0686

Figure A45. Load case 2B (section 17)



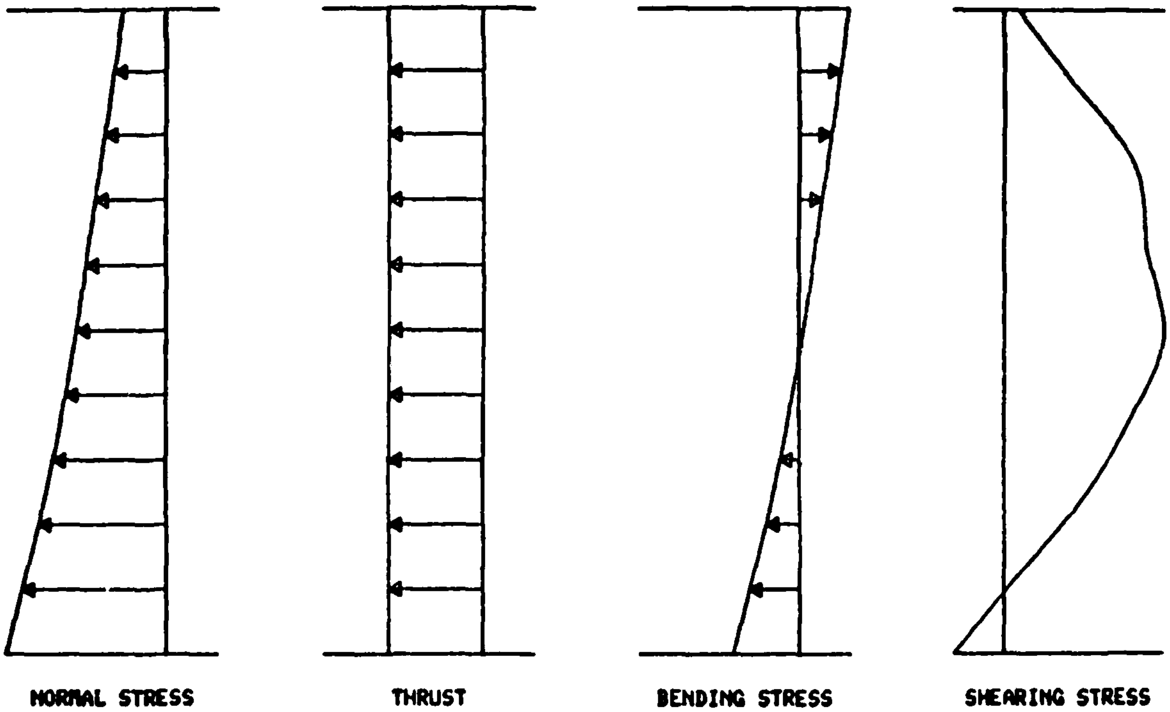
(X1, Y1) = (0.,-1.)
(X2, Y2) = (0.,13.)
NEUTRAL AXIS = (0.,6.)
SHEAR = -.0005
MOMENT = -12.13
THRUST = -.0002

Figure A46. Load case 2B (section 18)



(X1, Y1) = (62.,11.)
(X2, Y2) = (70.,11.)
NEUTRAL AXIS = (65.86,11.)
SHEAR = -.0096
MOMENT = -.1551
THRUST = -.278

Figure A47. Load case 2B (section 1A)



(X1, Y1) = (62.,21.)
(X2, Y2) = (70.,21.)
NEUTRAL AXIS = (65.84,21.)
SHEAR = .028
MOMENT = -.0952
THRUST = -.2363

Figure A48. Load case 2B (section 2A)

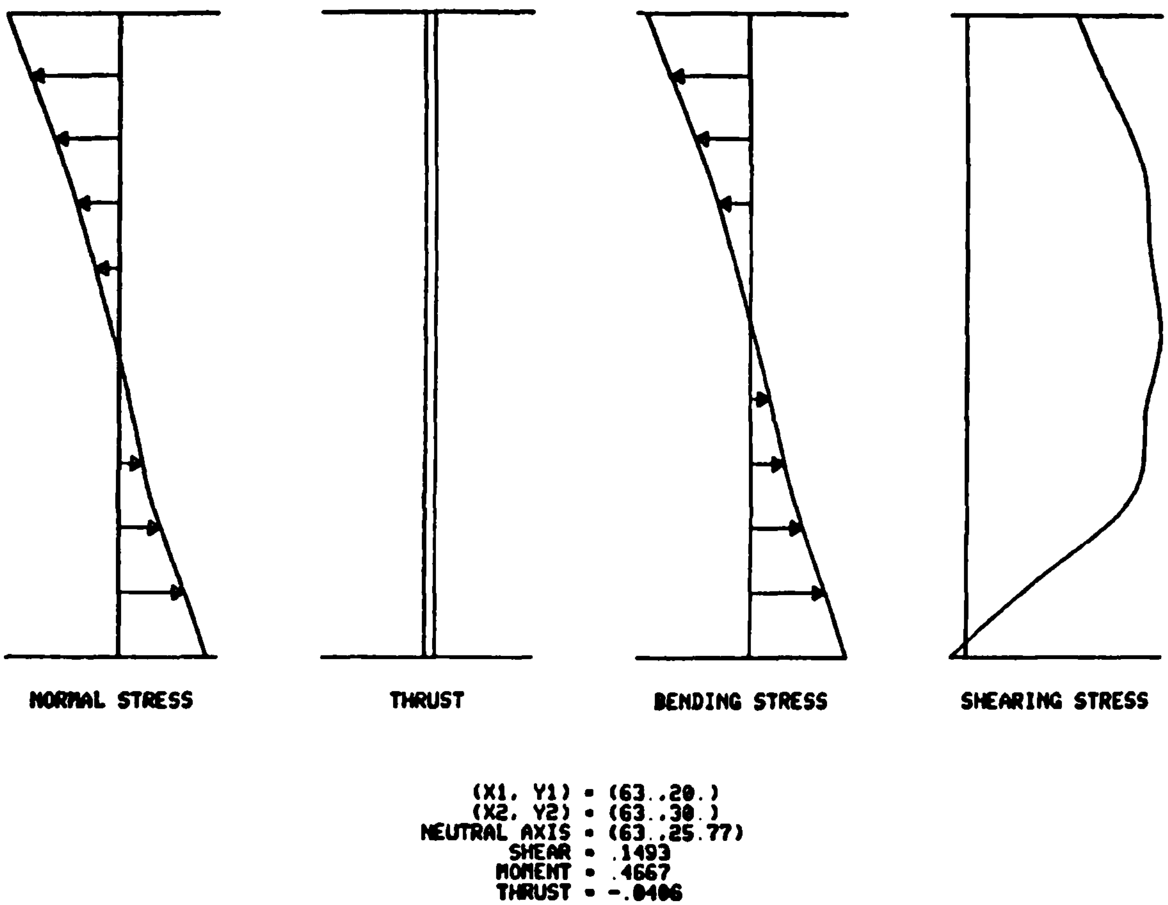
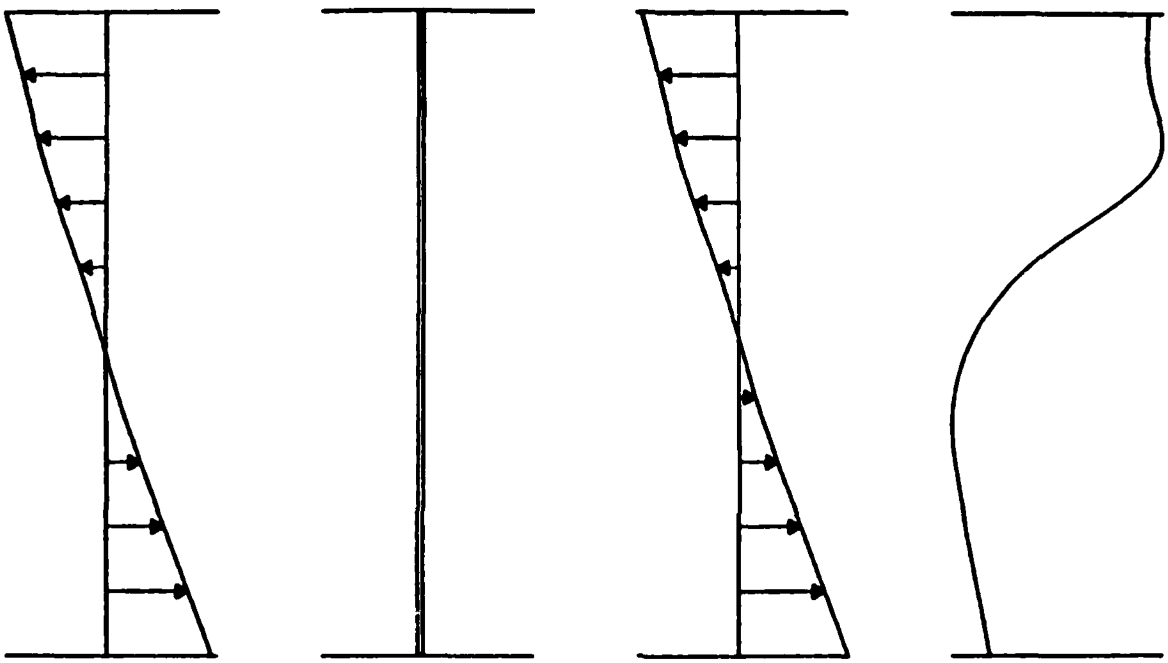
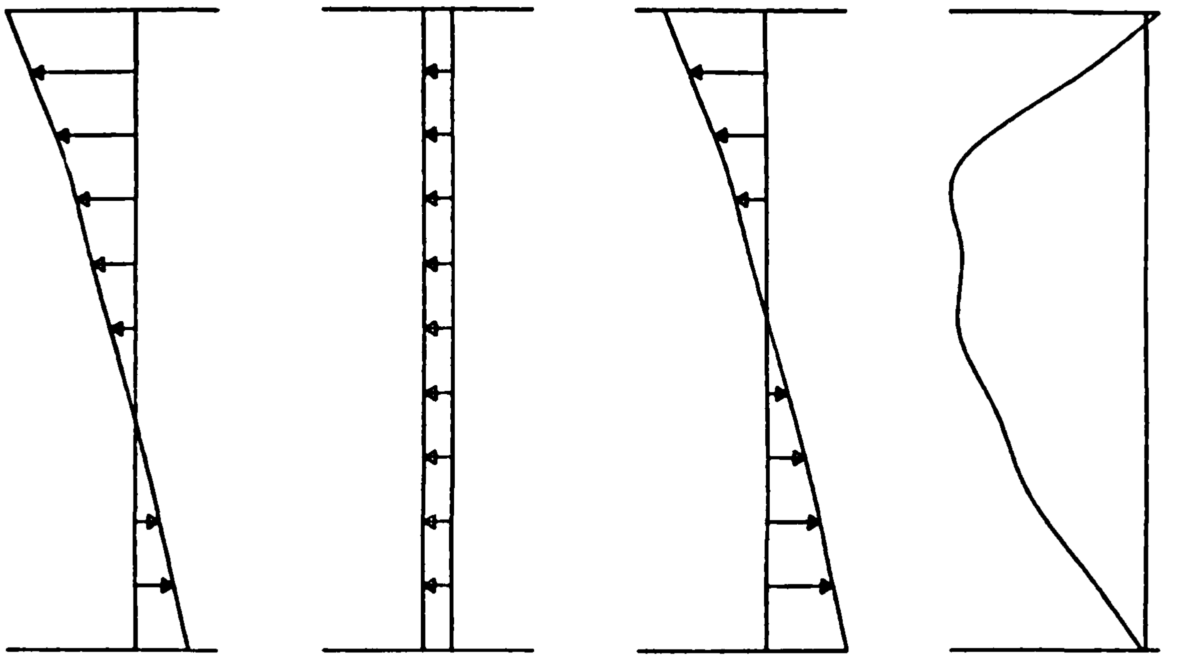


Figure A49. Load case 2B (section 3A)



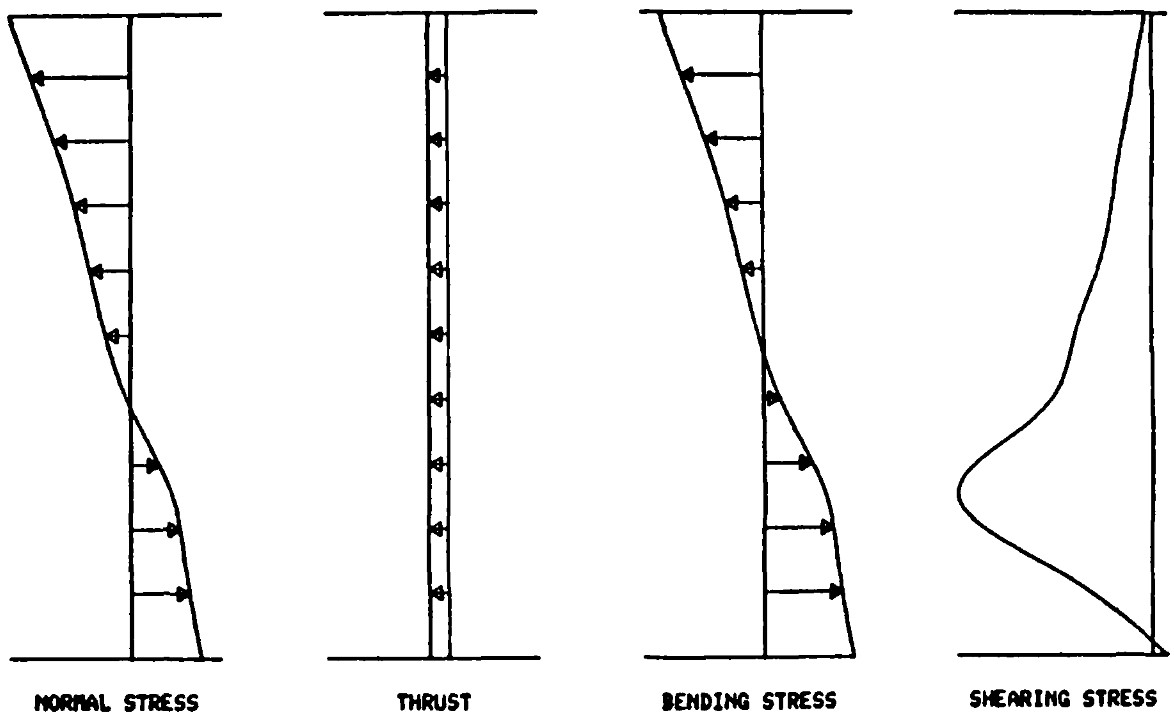
(X1, Y1) = (54.,20.)
(X2, Y2) = (54.,33.)
NEUTRAL AXIS = (54.,26.69)
SHEAR = .1213
MOMENT = 1.61
THRUST = -.0484

Figure A50. Load case 2B (section 4A)



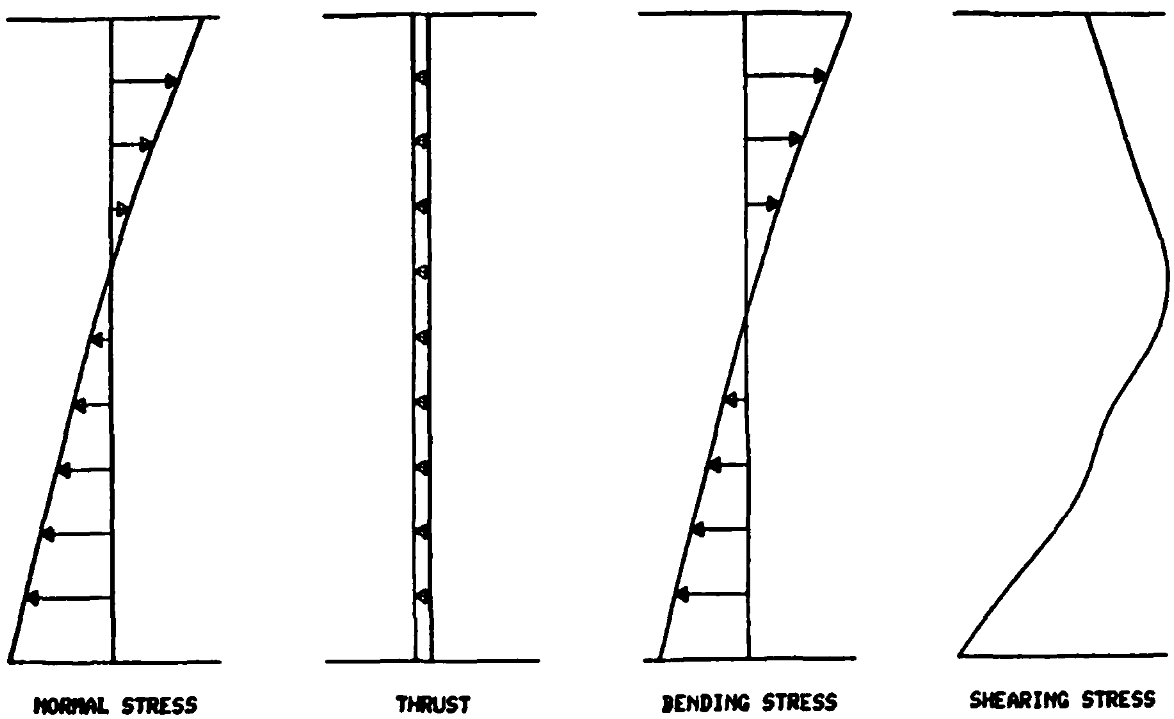
(X1, Y1) = (40.,20.)
(X2, Y2) = (54.,20.)
NEUTRAL AXIS = (47.2,20.)
SHEAR = -.2684
MOMENT = 1.553
THRUST = -.2077

Figure A51. Load case 2B (section 5A)



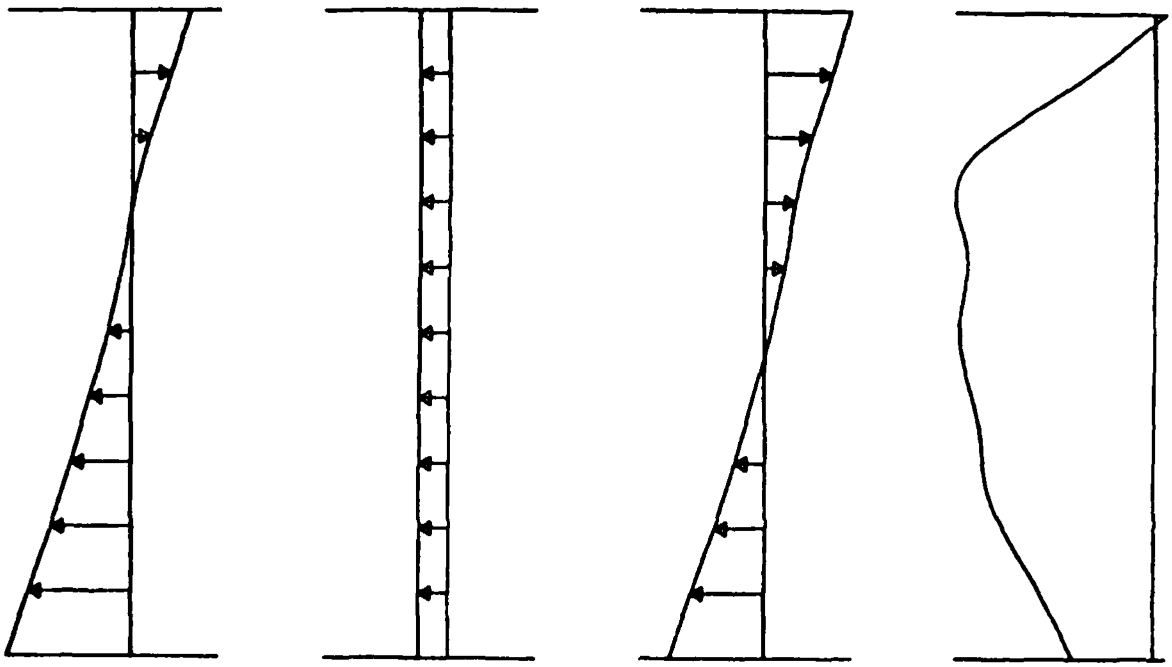
(X1, Y1) = (40.,14.)
(X2, Y2) = (54.,14.)
NEUTRAL AXIS = (46.75,14.)
SHEAR = -.2806
MOMENT = 3.137
THRUST = -.3522

Figure A52. Load case 2B (section 6A)



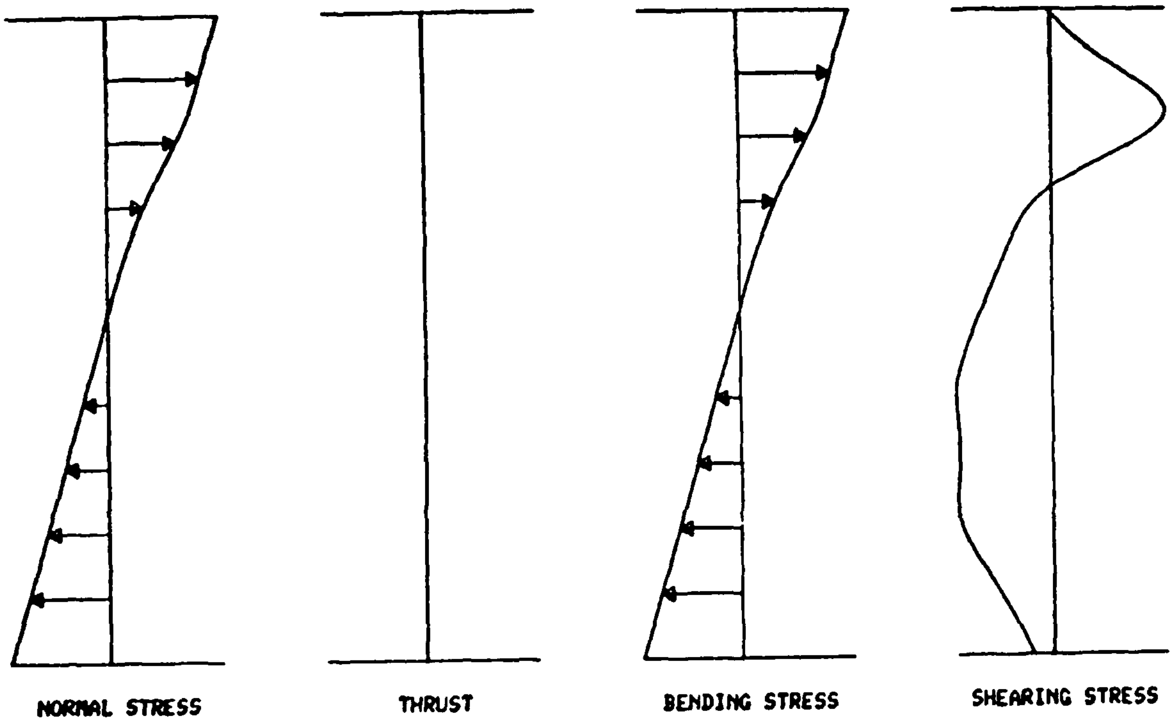
(X1, Y1) = (54.,1.)
(X2, Y2) = (54.,11.)
NEUTRAL AXIS = (54.,6.367)
SHEAR = -.0832
MOMENT = -1.396
THRUST = -.177

Figure A53. Load case 2B (section 7A)



(X1, Y1) = (63.,3.)
(X2, Y2) = (63.,11.)
NEUTRAL AXIS = (63.,6.816)
SHEAR = -.1528
MOMENT = -.3612
THRUST = -.123

Figure A54. Load case 2B (section 8A)



(X1, Y1) = (40.,-1.)
(X2, Y2) = (40.,13.)
NEUTRAL AXIS = (40.,6.432)
SHEAR = -.1654
MOMENT = -8.542
THRUST = -.0024

Figure A55. Load case 2B (section 9A)

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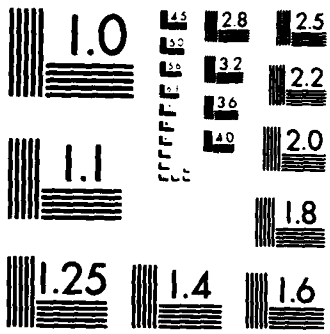

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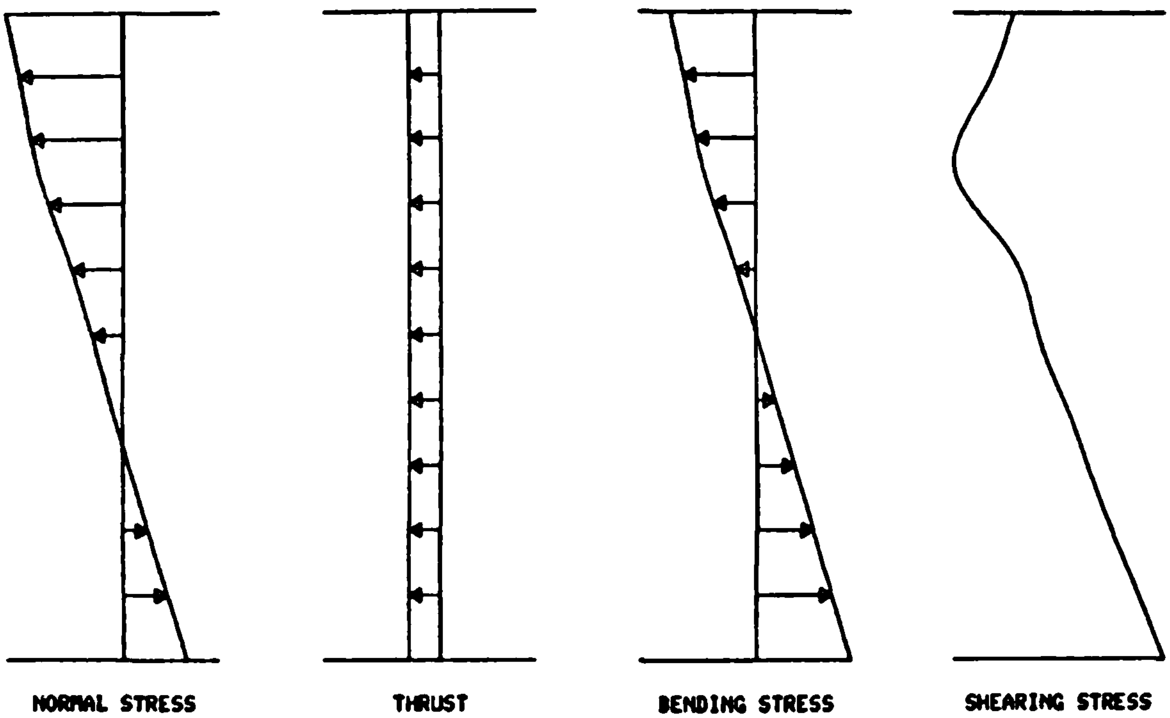
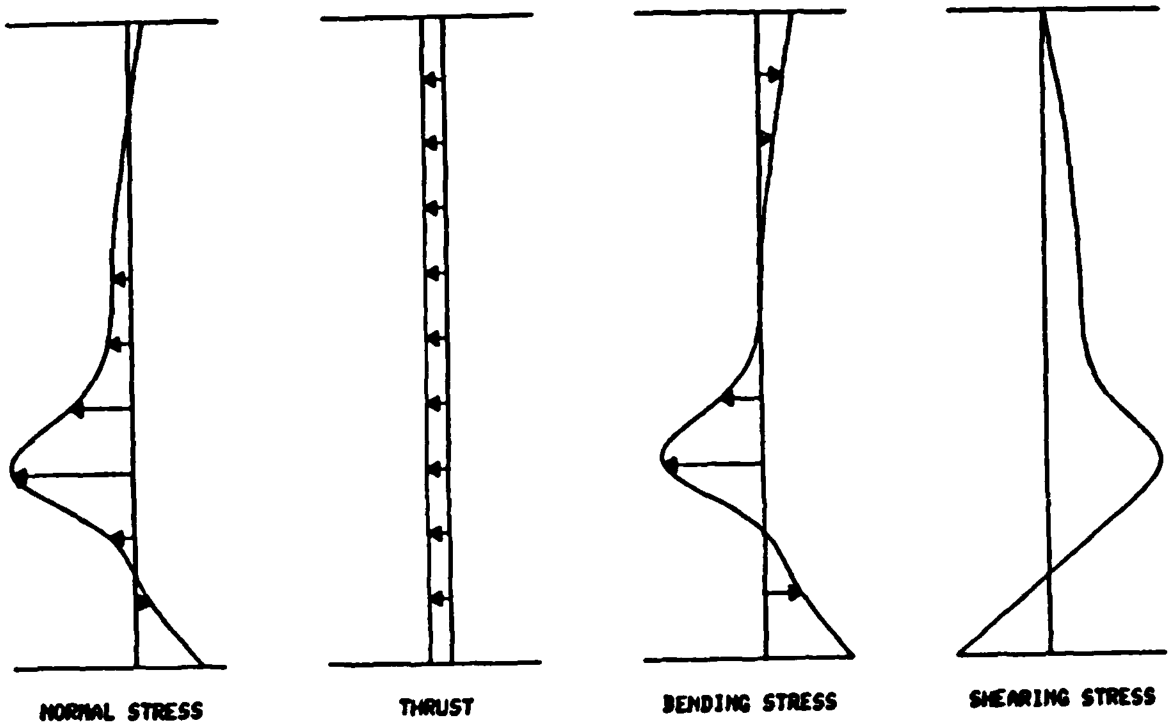


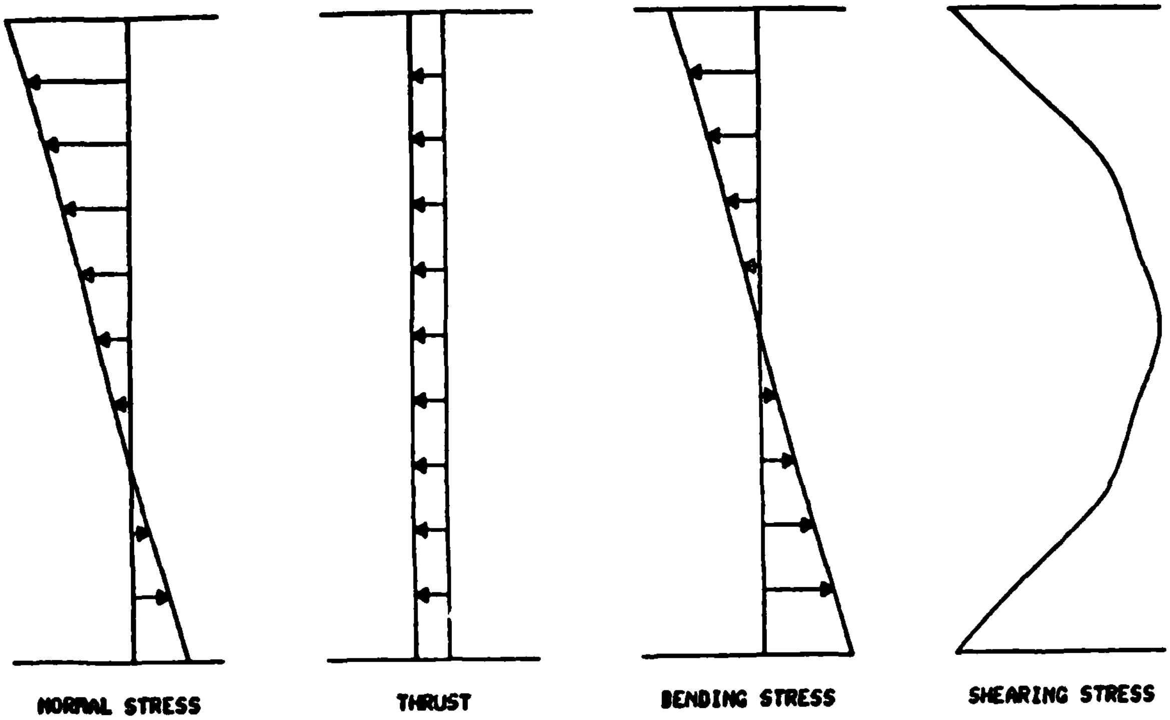
(X1, Y1) = (40.,36.)
(X2, Y2) = (52.,36.)
NEUTRAL AXIS = (46.55,36.)
SHEAR = -.1335
MOMENT = 1.112
THRUST = -.2476

Figure A56. Load case 2B (section 10A)



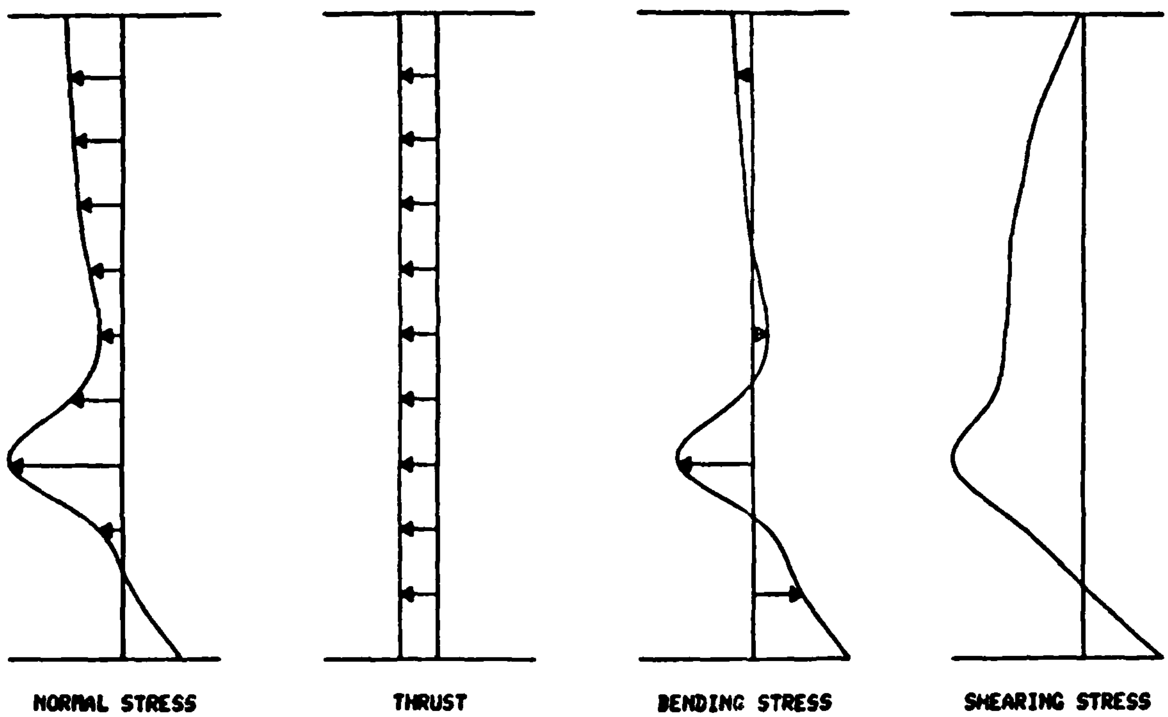
(X1, Y1) = (62.,10.)
(X2, Y2) = (70.,10.)
NEUTRAL AXIS = (65.4,10.)
SHEAR = .1567
MOMENT = -.0675
THRUST = -.1845

Figure A57. Load case 5A (section 1)



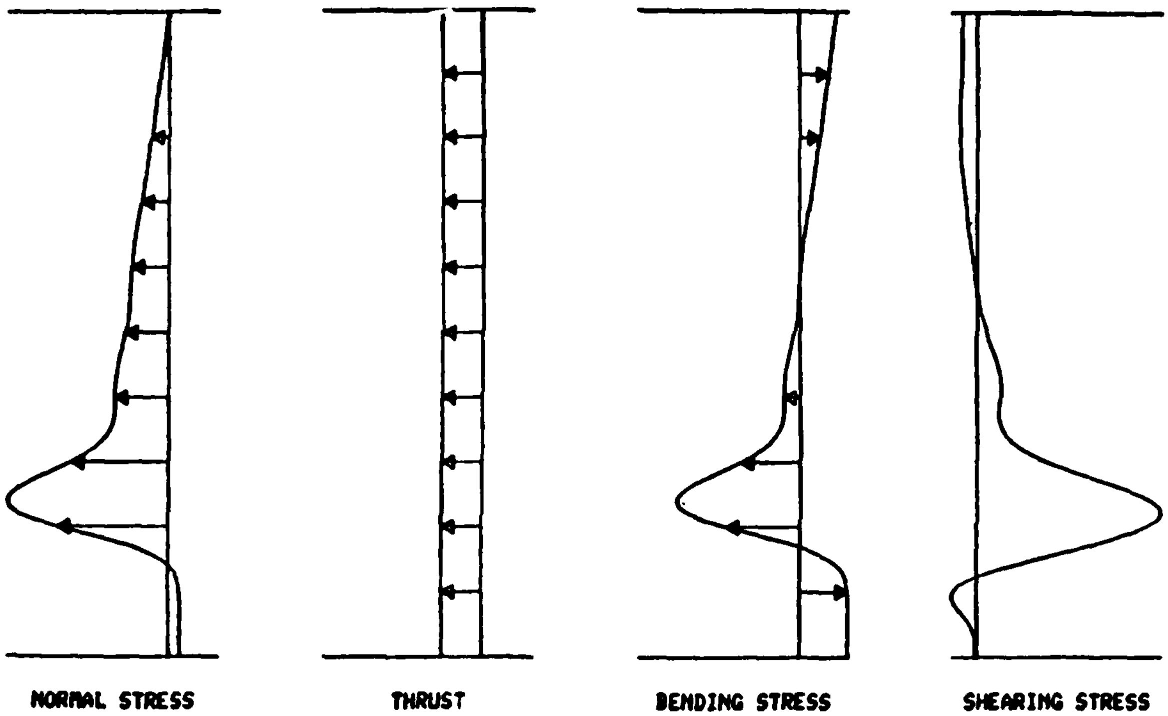
(X1, Y1) = (62 ,16.)
(X2, Y2) = (70 ,16.)
NEUTRAL AXIS = (66 ,16.)
SHEAR = .0158
MOMENT = .2491
THRUST = -.1456

Figure A58. Load case 5A (section 2)



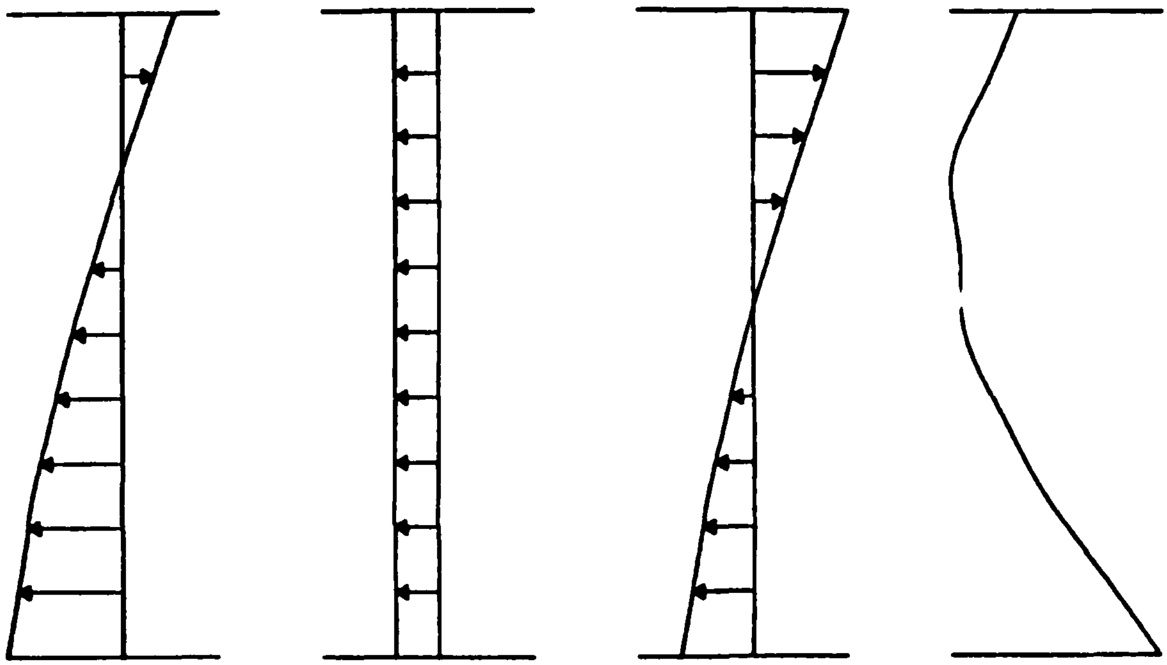
(X1, Y1) = (62 ,22.)
(X2, Y2) = (70 ,22.)
NEUTRAL AXIS = (65 91.22.)
SHEAR = -.1093
MOMENT = .0896
THRUST = -.1277

Figure A59. Load case 5A (section 3)



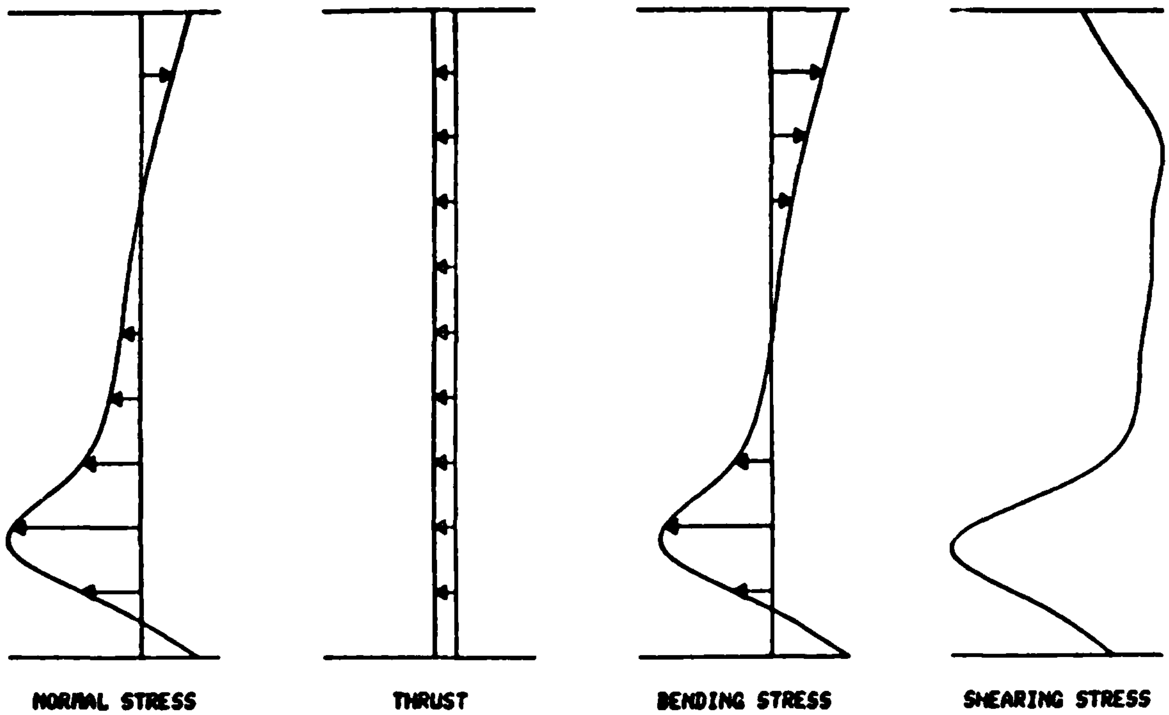
(X1, Y1) = (64 ,20.)
(X2, Y2) = (64 ,30.)
NEUTRAL AXIS = (64 ,25.28)
SHEAR = .0472
MOMENT = -.1636
THRUST = -.22

Figure A60. Load case 5A (section 4)



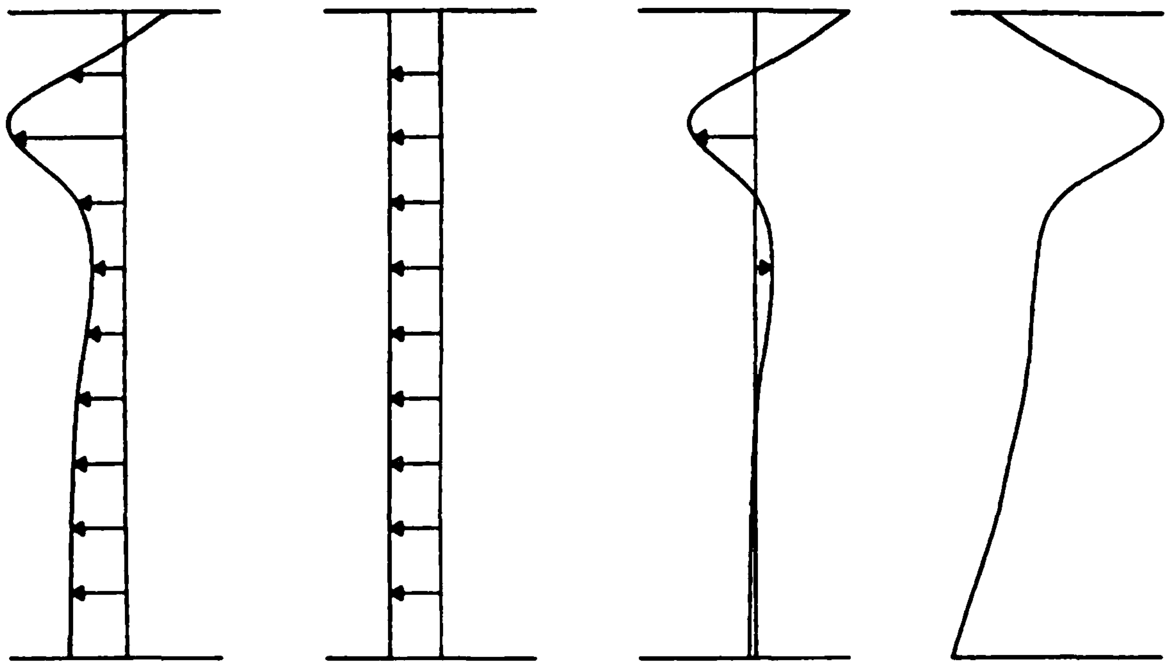
(X1, Y1) = (58 ,20)
(X2, Y2) = (58 ,32)
NEUTRAL AXIS = (58 ,26.56)
SHEAR = -.1043
MOMENT = -.628
THRUST = -.2237

Figure A61. Load case 5A (section 5)



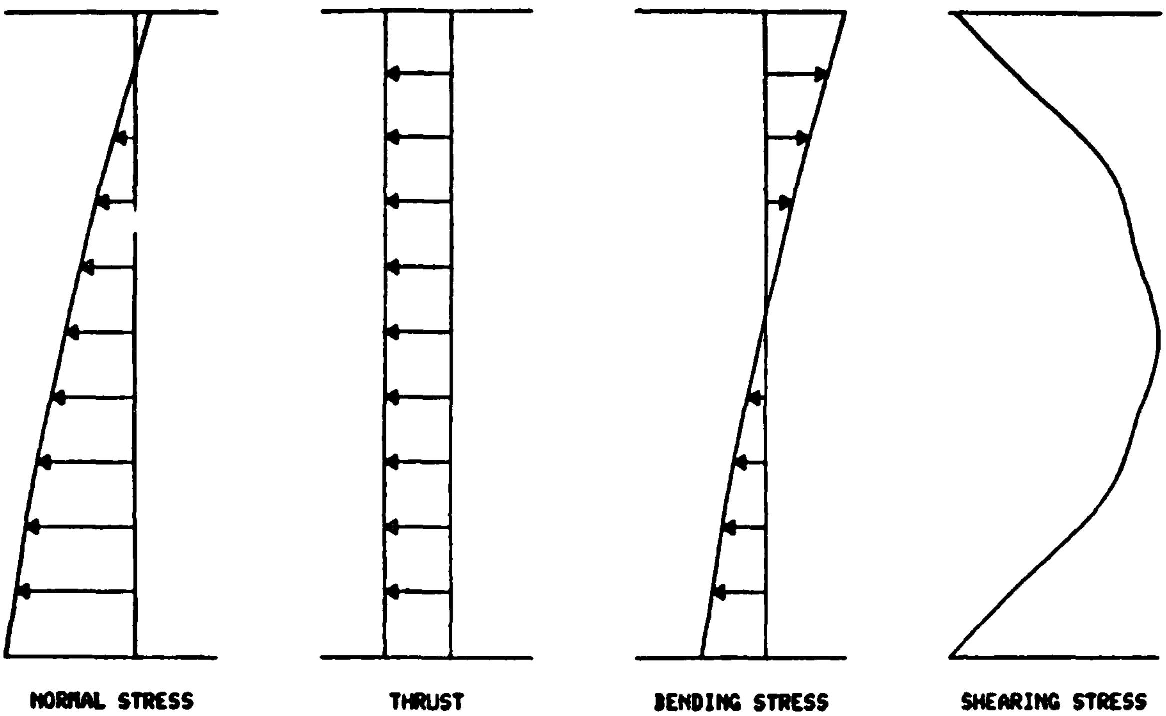
(X1, Y1) = (52 .20)
(X2, Y2) = (52 .33)
NEUTRAL AXIS = (52 .25.77)
SHEAR = -.2874
MOMENT = -1.63
THRUST = -.317

Figure A62. Load case 5A (section 6)



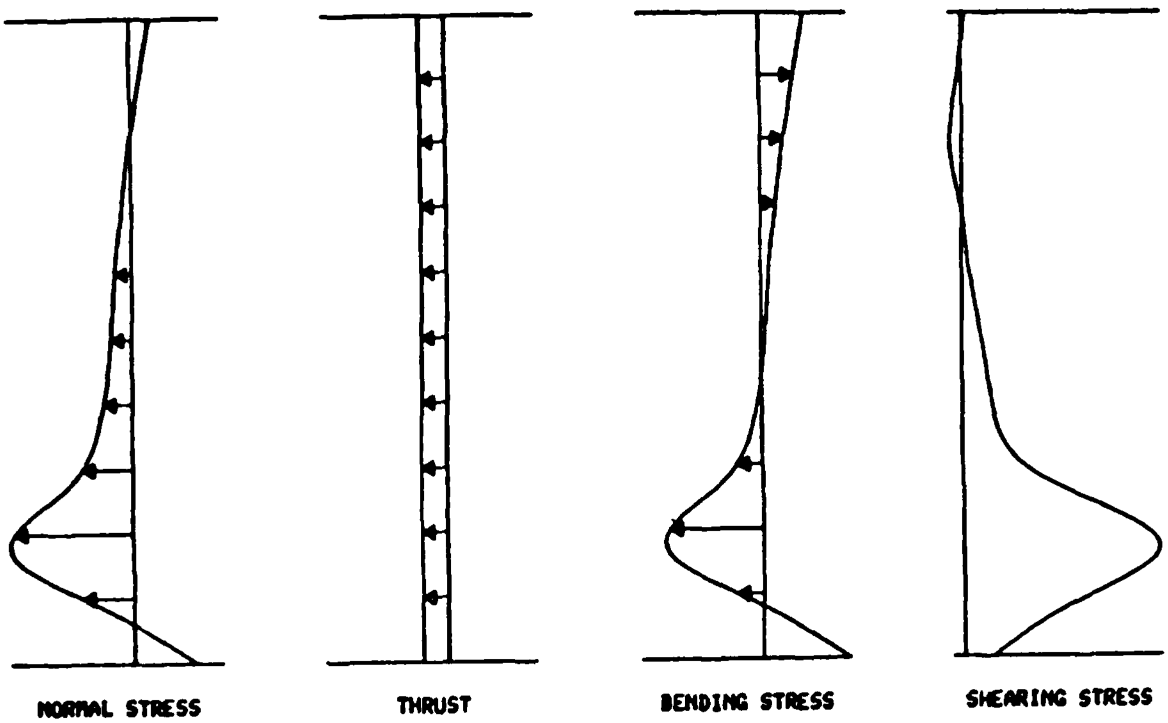
(X1, Y1) = (48 ,22.)
(X2, Y2) = (54 ,22.)
NEUTRAL AXIS = (52 81.22.)
SHEAR = .3724
MOMENT = -.1478
THRUST = -.7049

Figure A63. Load case 5A (section 7)



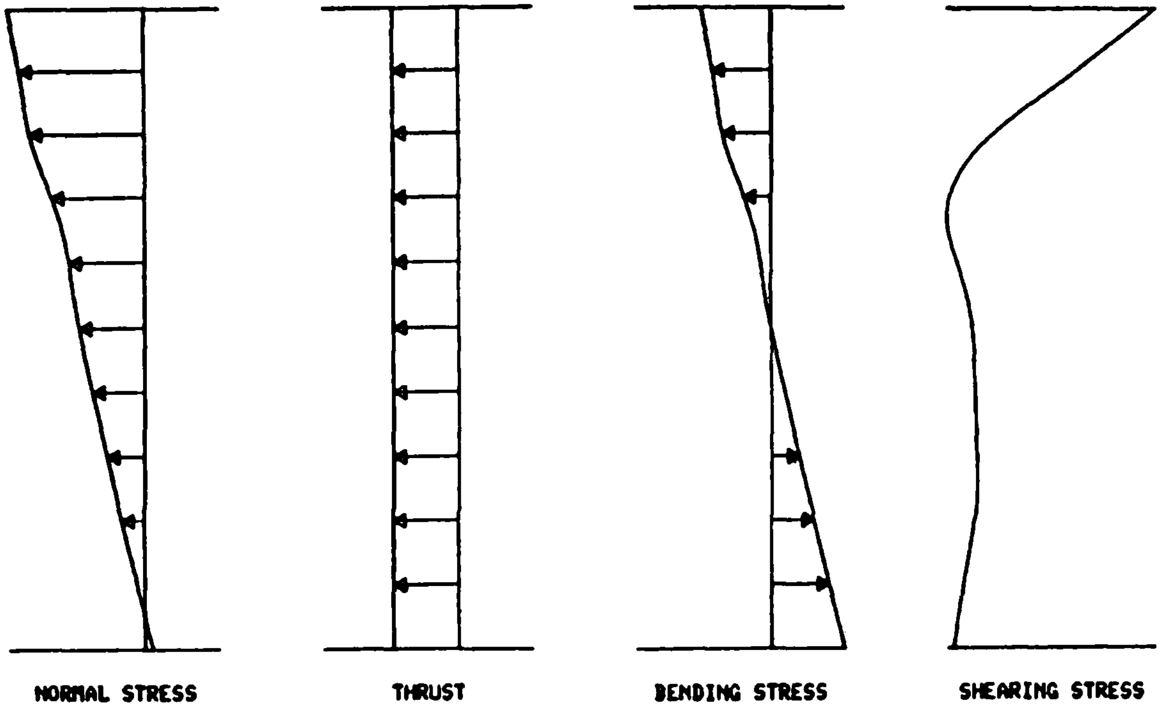
(X1, Y1) = (40 ,17.)
(X2, Y2) = (54 ,17.)
NEUTRAL AXIS = (47 26.17.)
SHEAR = .3265
MOMENT = -1.323
THRUST = -.7197

Figure A64. Load case 5A (section 8)



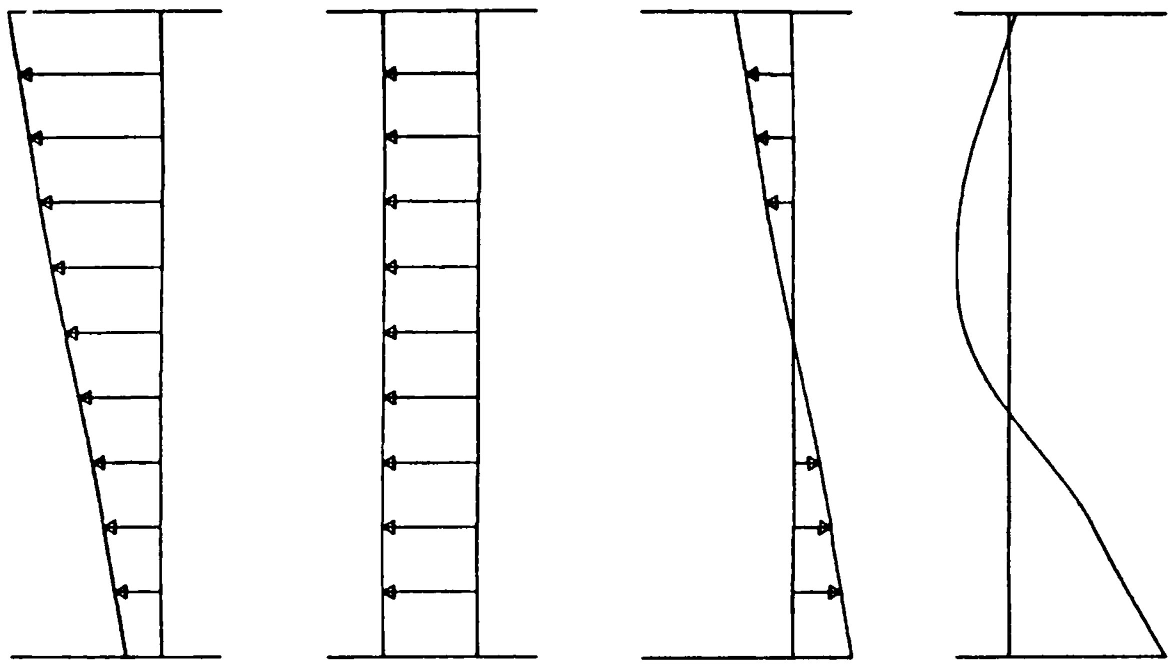
(X1, Y1) = (40 .12.)
(X2, Y2) = (54 .12.)
NEUTRAL AXIS = (45 36.12.)
SHEAR = .4446
MOMENT = -2 444
THRUST = -.8664

Figure A65. Load case 5A (section 9)



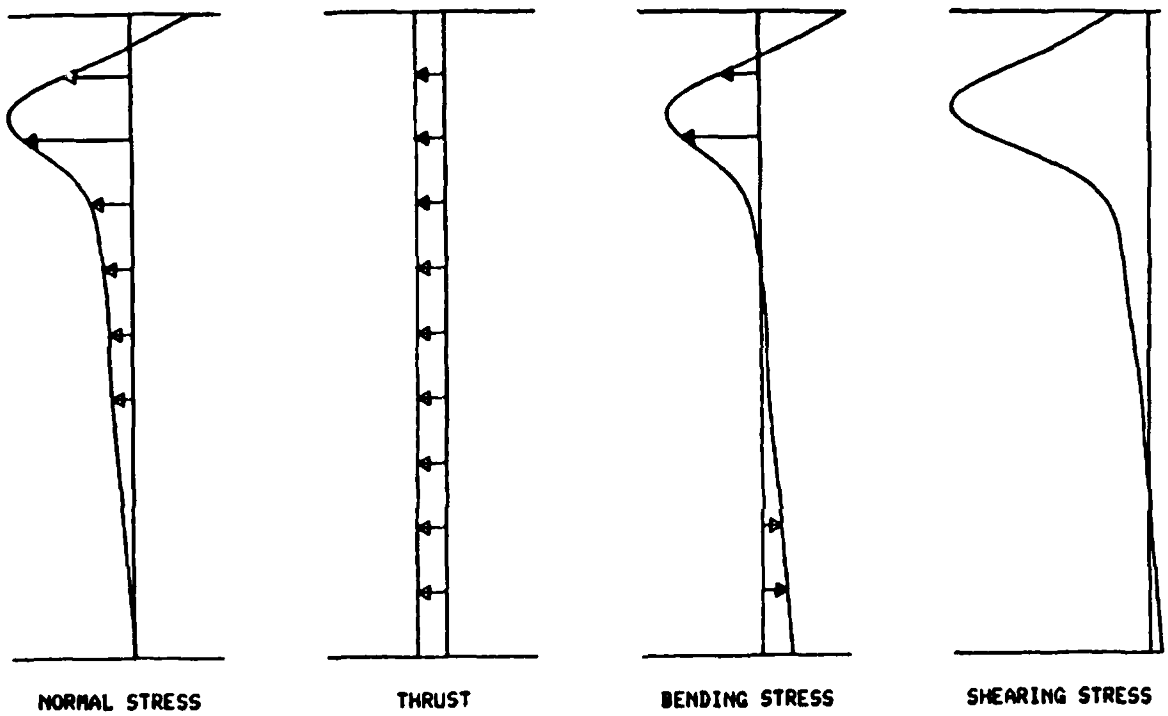
(X1, Y1) = (52 .1)
(X2, Y2) = (52 .11)
NEUTRAL AXIS = (52 .6.518)
SHEAR = .1377
MOMENT = .7629
THRUST = -.4541

Figure A66. Load case 5A (section 10)



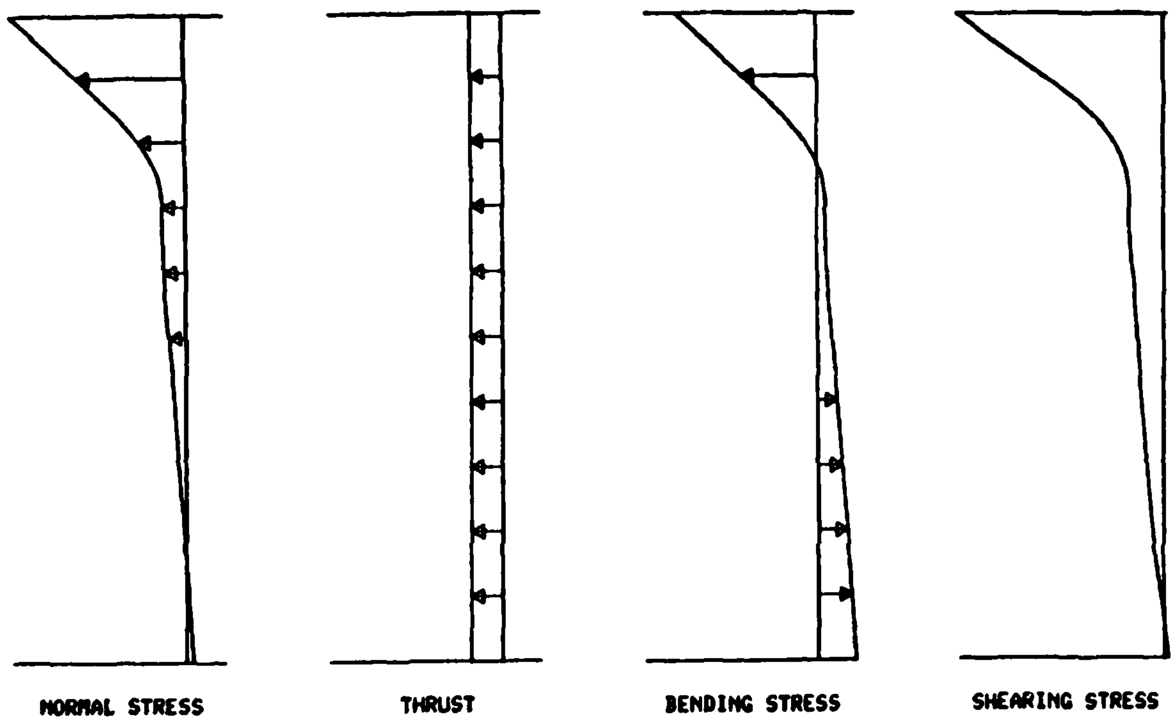
(X1, Y1) = (58 ,2)
(X2, Y2) = (58 ,11)
NEUTRAL AXIS = (58 ,6.486)
SHEAR = .0012
MOMENT = .2525
THRUST = -.3404

Figure A67. Load case 5A (section 11)



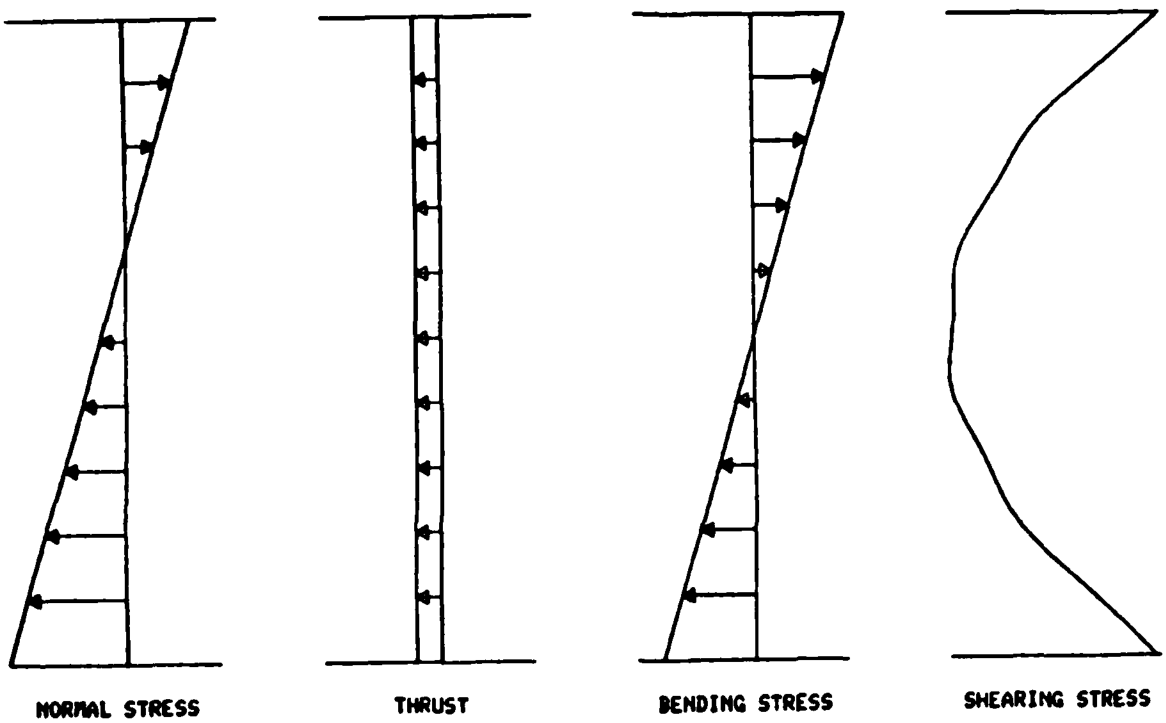
(X1, Y1) = (64 ,3)
(X2, Y2) = (64 ,11)
NEUTRAL AXIS = (64 ,10.5)
SHEAR = - 1437
MOMENT = 3856
THRUST = - 3402

Figure A68. Load case 5A (section 12)



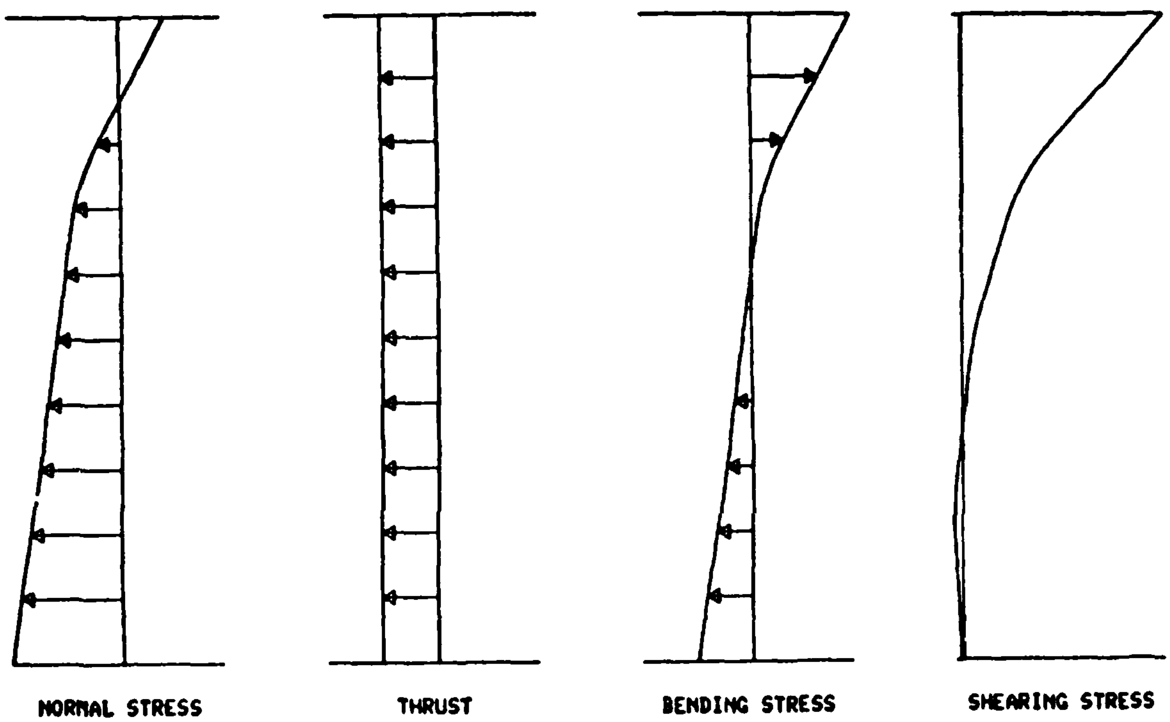
(X1, Y1) = (42 ,-1)
(X2, Y2) = (42 ,13)
NEUTRAL AXIS = (42 ,9.772)
SHEAR = -.655
MOMENT = 4.574
THRUST = -1.066

Figure A69. Load case 5A (section 13)



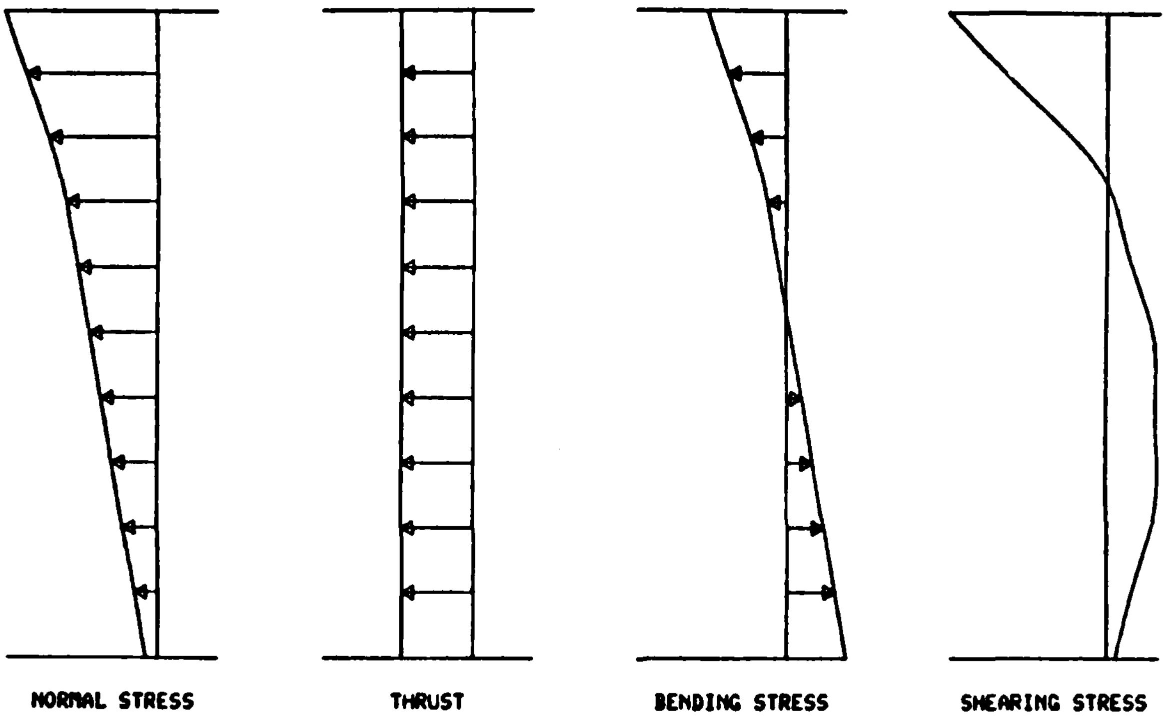
(X1, Y1) = (20 ,-1)
(X2, Y2) = (20 ,13)
NEUTRAL AXIS = (20 ,6.001)
SHEAR = -.2533
MOMENT = -5.444
THRUST = -.7476

Figure A70. Load case 5A (section 14)



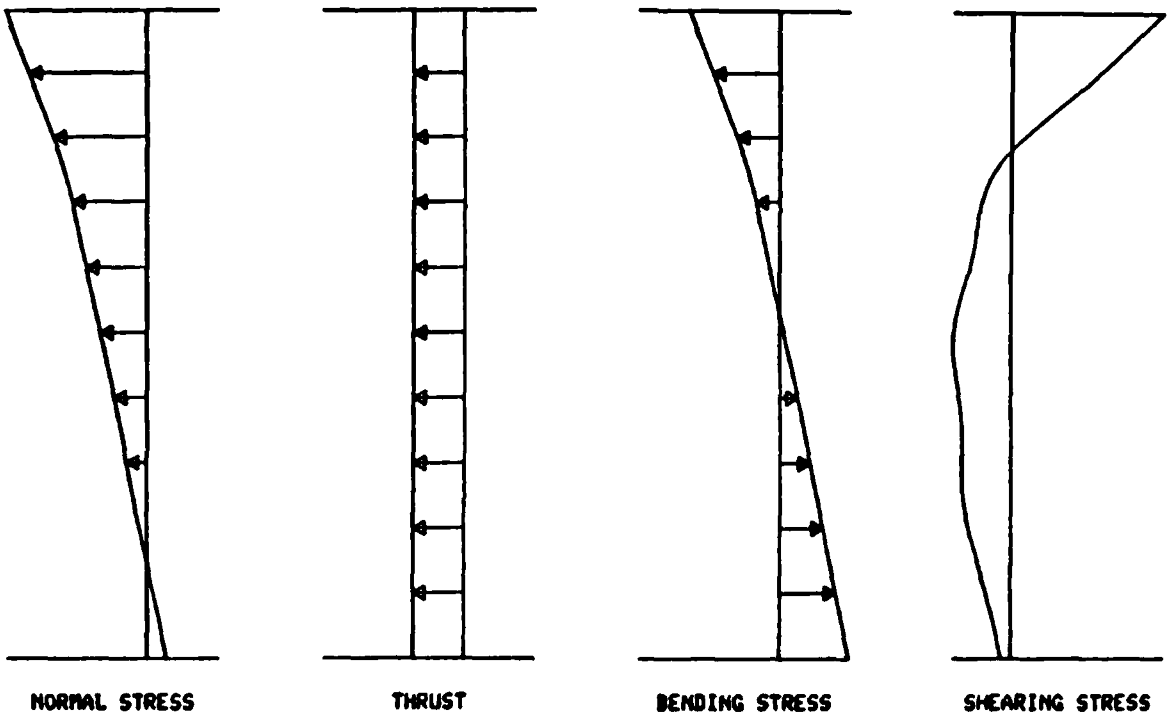
(X1, Y1) = (40 .32)
(X2, Y2) = (53 .32)
NEUTRAL AXIS = (48 01.32)
SHEAR = .0628
MOMENT = -.636
THRUST = -.3185

Figure A71. Load case 5A (section 15)



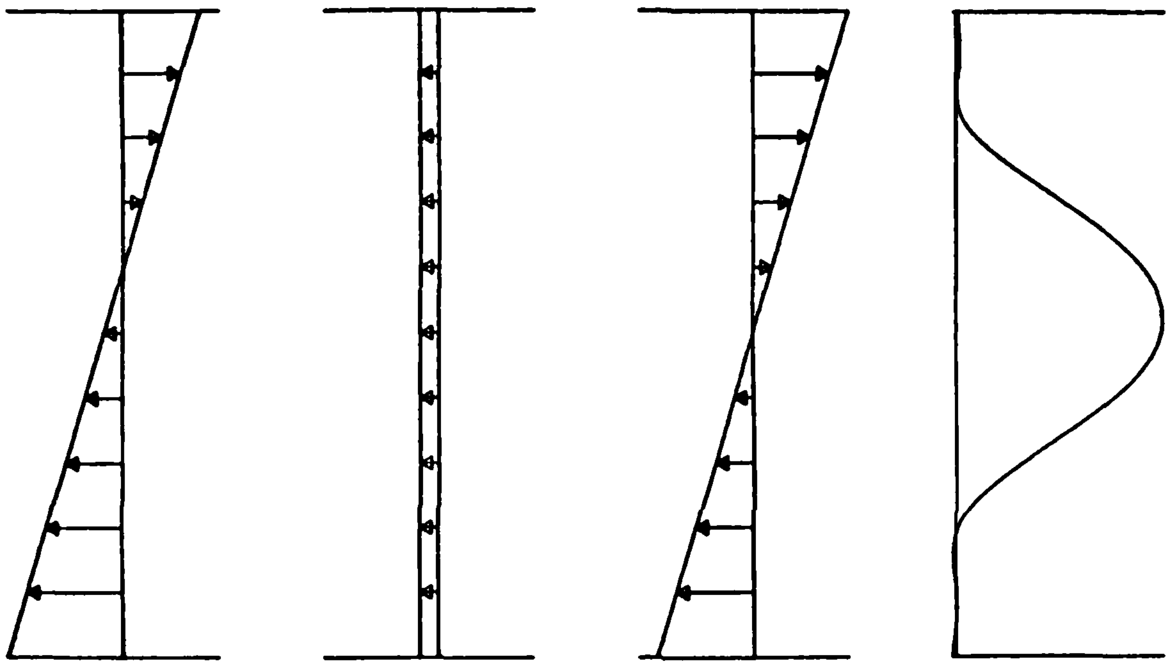
(X1, Y1) = (40 .53)
(X2, Y2) = (48 .53)
NEUTRAL AXIS = (44 67.53)
SHEAR = .0006
MOMENT = .0877
THRUST = -.1158

Figure A72. Load case 5A (section 16)



(X1, Y1) = (40 .63)
(X2, Y2) = (48 .63)
NEUTRAL AXIS = (44.65.63.)
SHEAR = -.0037
MOMENT = .0853
THRUST = -.0686

Figure A73. Load case 5A (section 17)



(X1, Y1) = (0 ,-1)
(X2, Y2) = (0 .13)
NEUTRAL AXIS = (0 .6 001)
SHEAR = 0088
MOMENT = -7 779
THRUST = -.7476

Figure A74. Load case 5A (section 18)

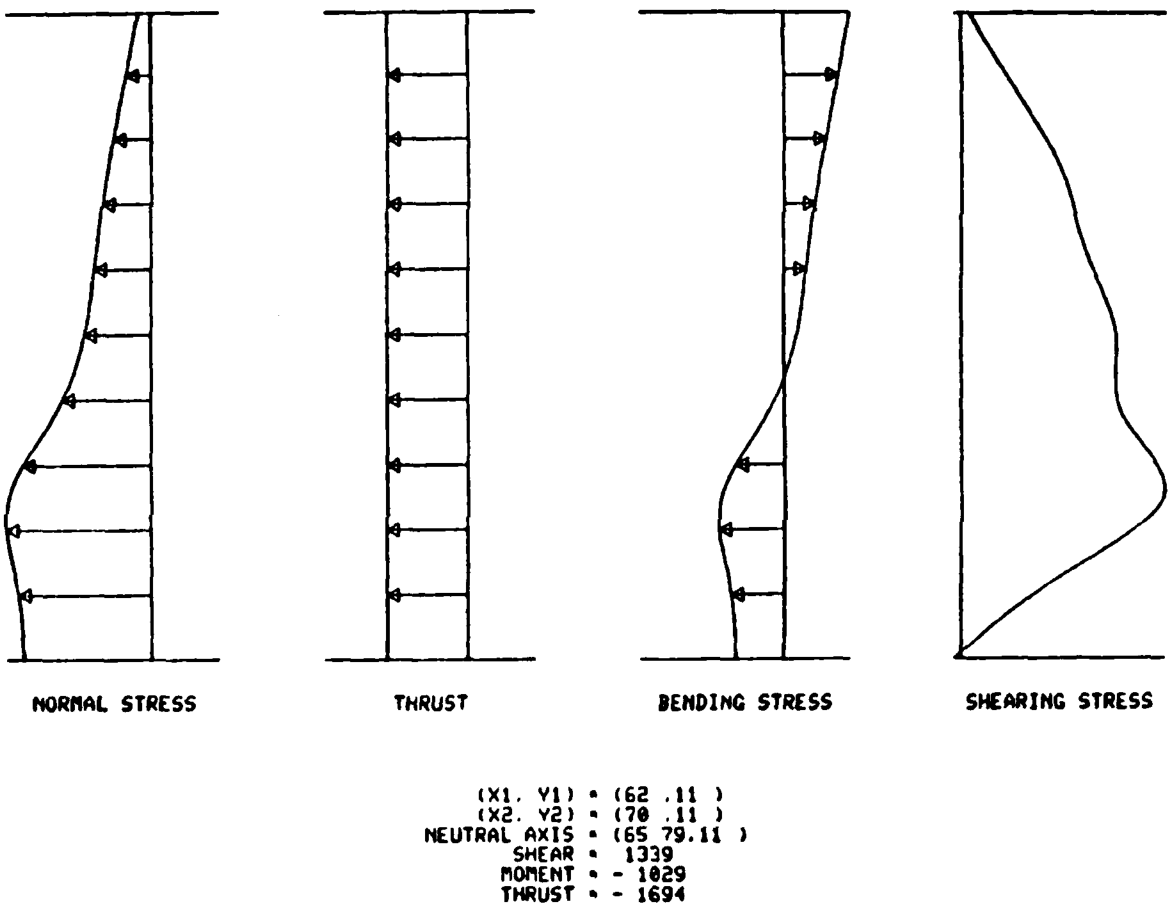


Figure A75. Load case 5A (section 1A)

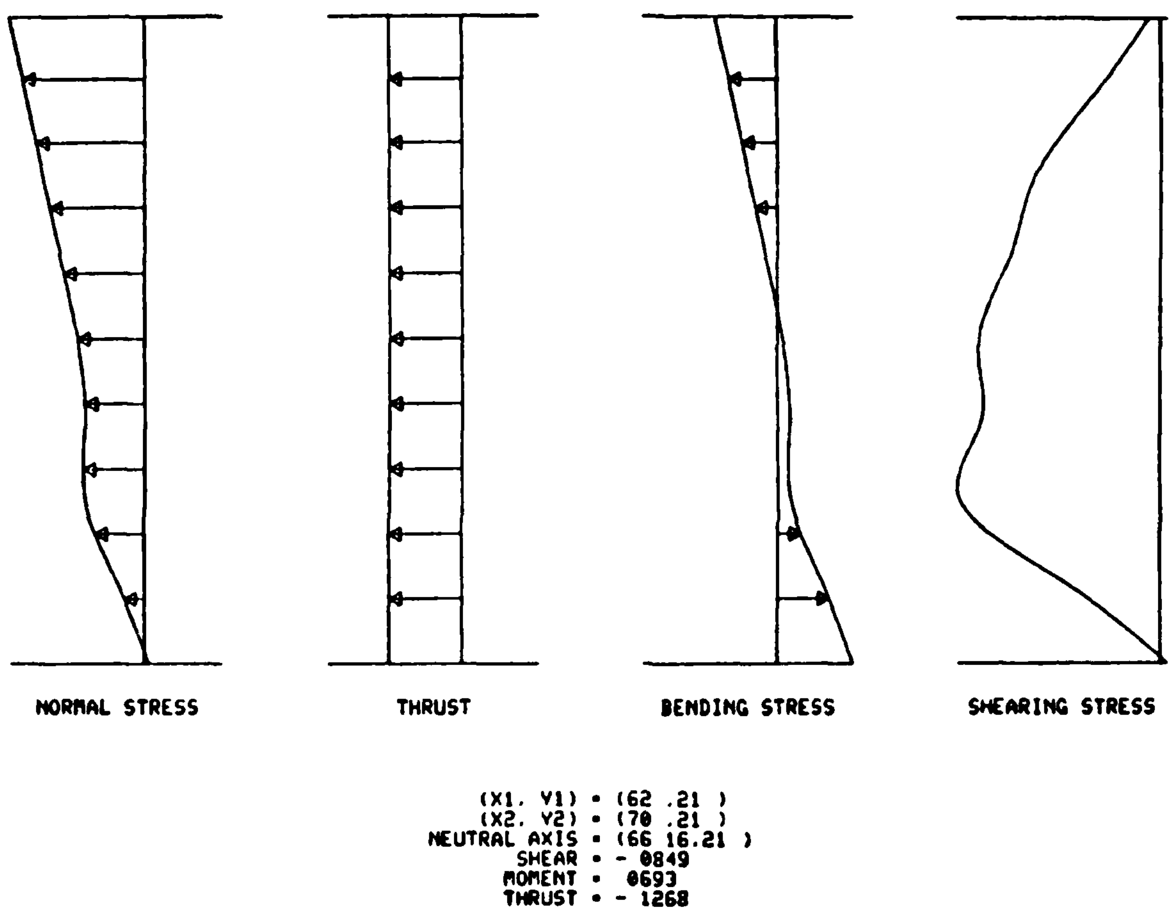
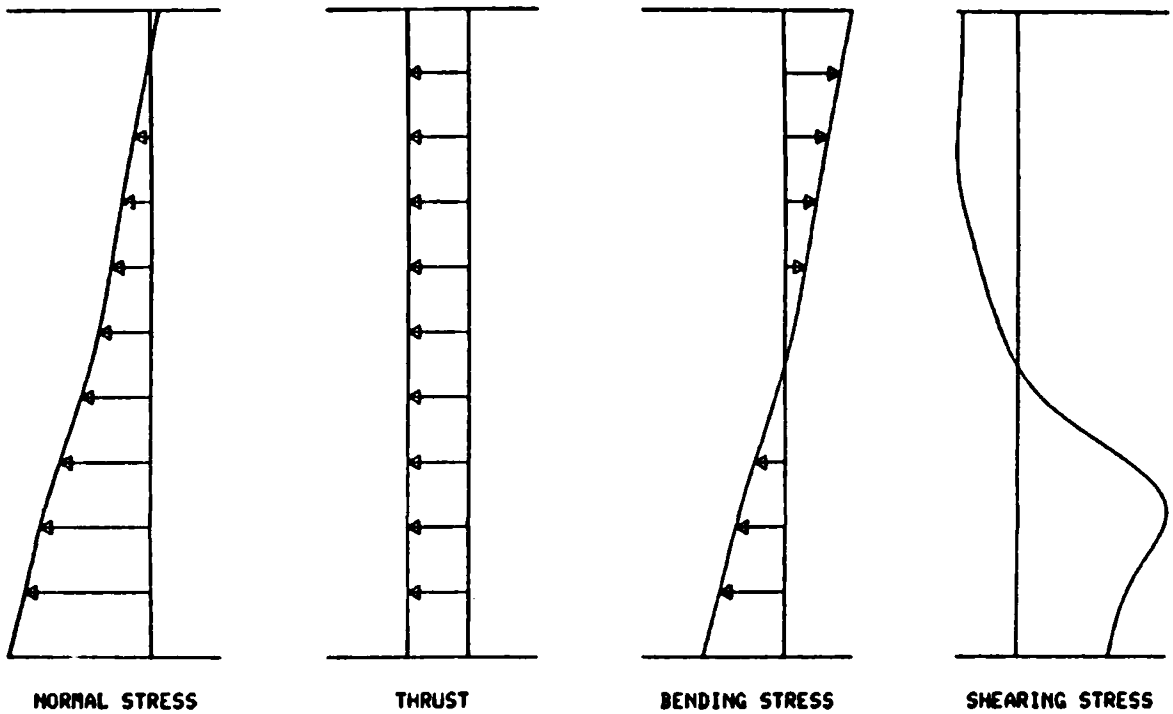
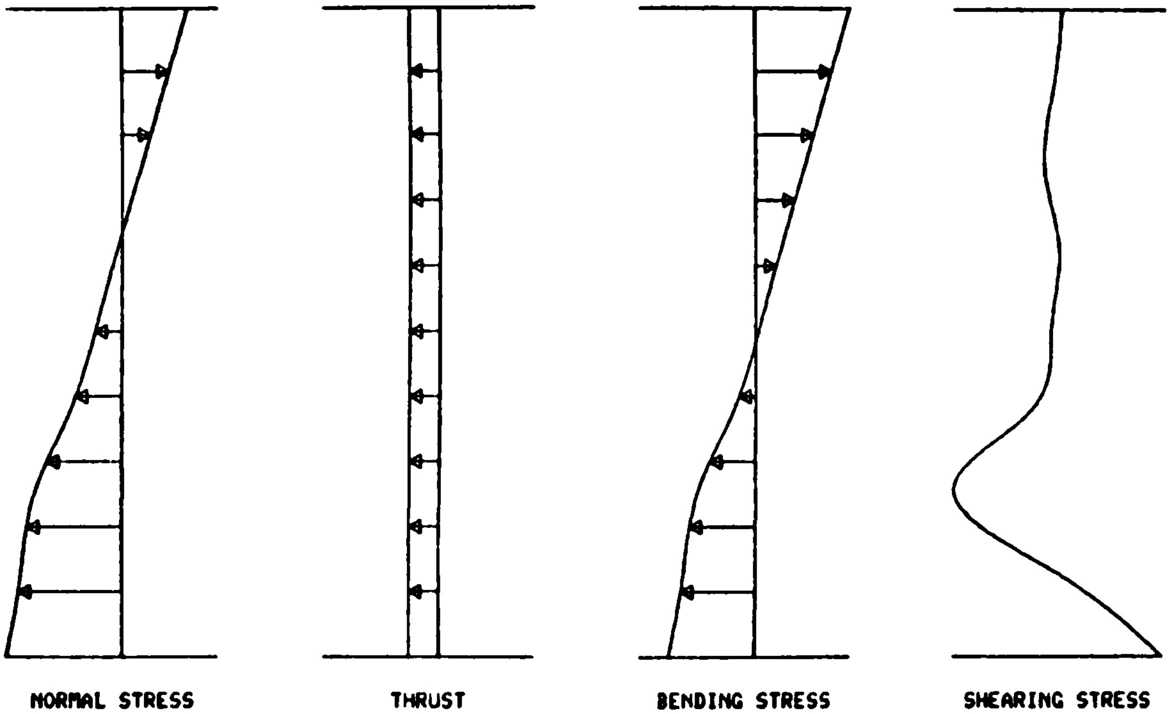


Figure A76. Load case 5A (section 2A)



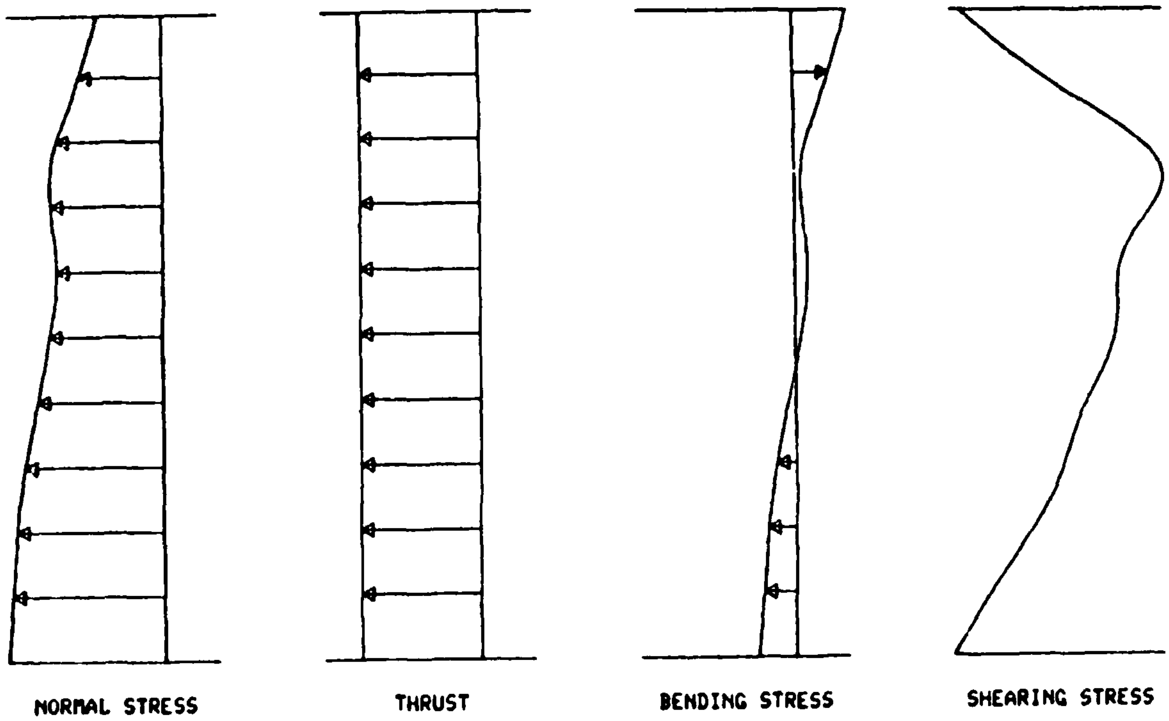
(X1, Y1) = (63 .20)
(X2, Y2) = (63 .30)
NEUTRAL AXIS = (63 .25 29)
SHEAR = .0107
MOMENT = - 3057
THRUST = -.2012

Figure A77. Load case 5A (section 3A)



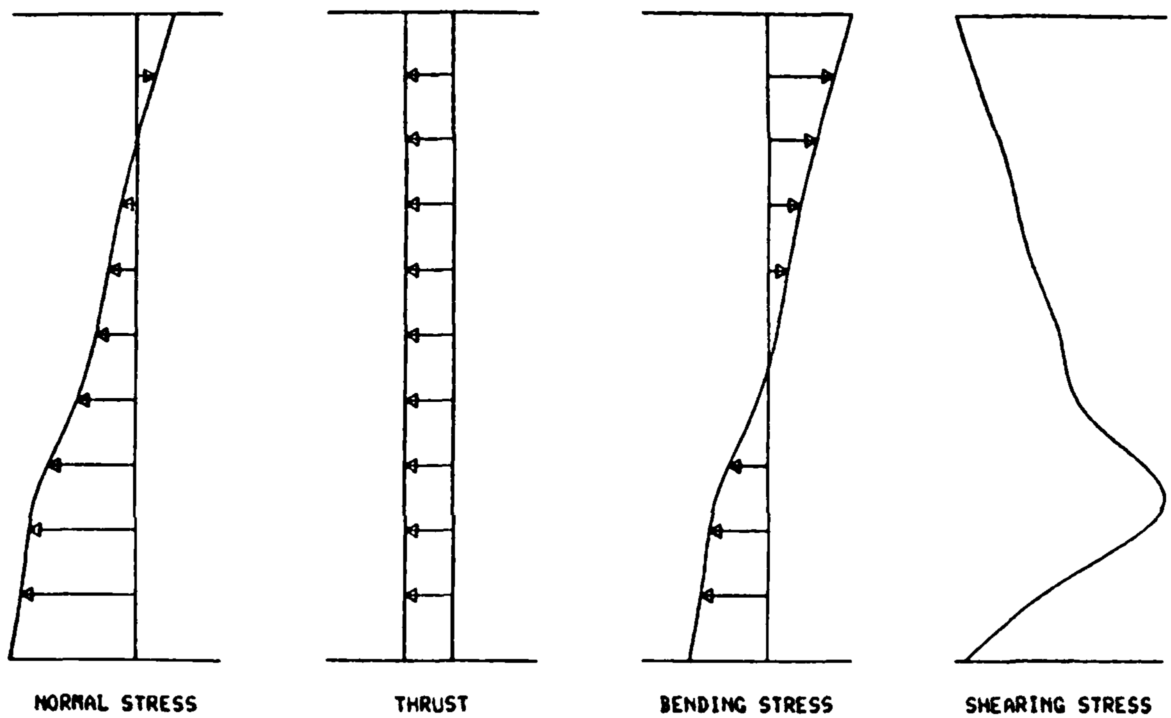
(X1, Y1) = (54 .20)
(X2, Y2) = (54 .33)
NEUTRAL AXIS = (54 .26 61)
SHEAR = - 204
MOMENT = -1 24
THRUST = - 2416

Figure A78. Load case 5A (section 4A)



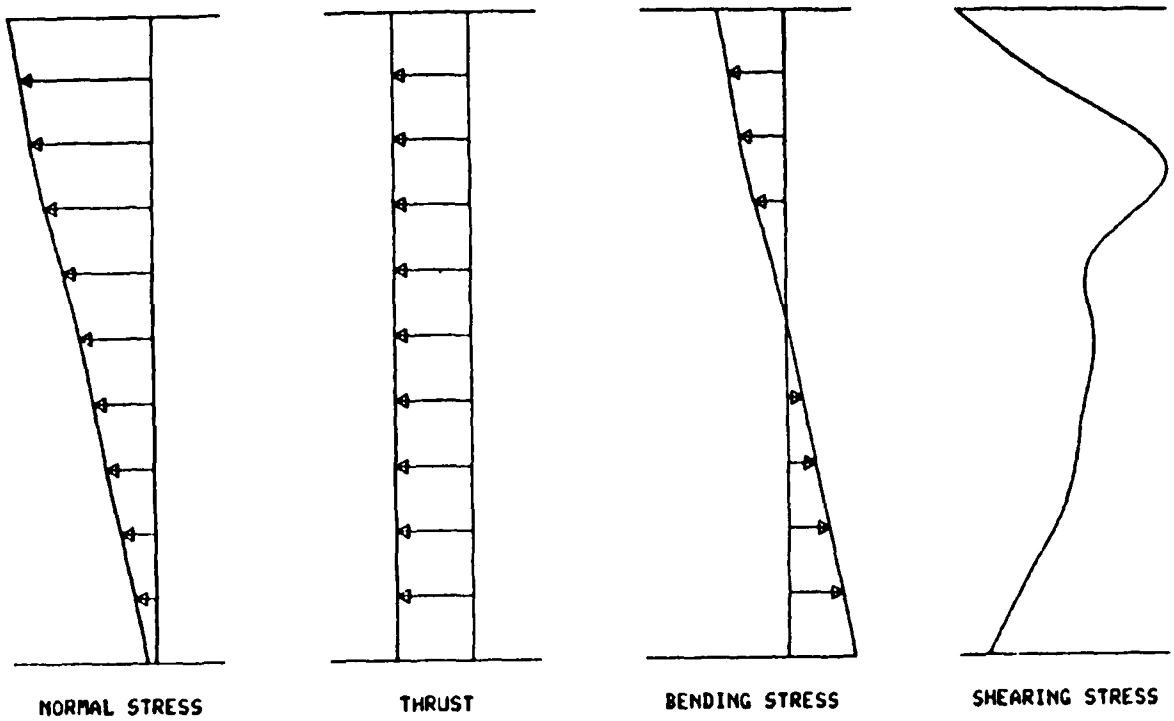
(X1, Y1) = (40 .20)
(X2, Y2) = (54 .20)
NEUTRAL AXIS = (46 49.20)
SHEAR = 3266
MOMENT = - 3843
THRUST = - 6706

Figure A79. Load case 5A (section 5A)



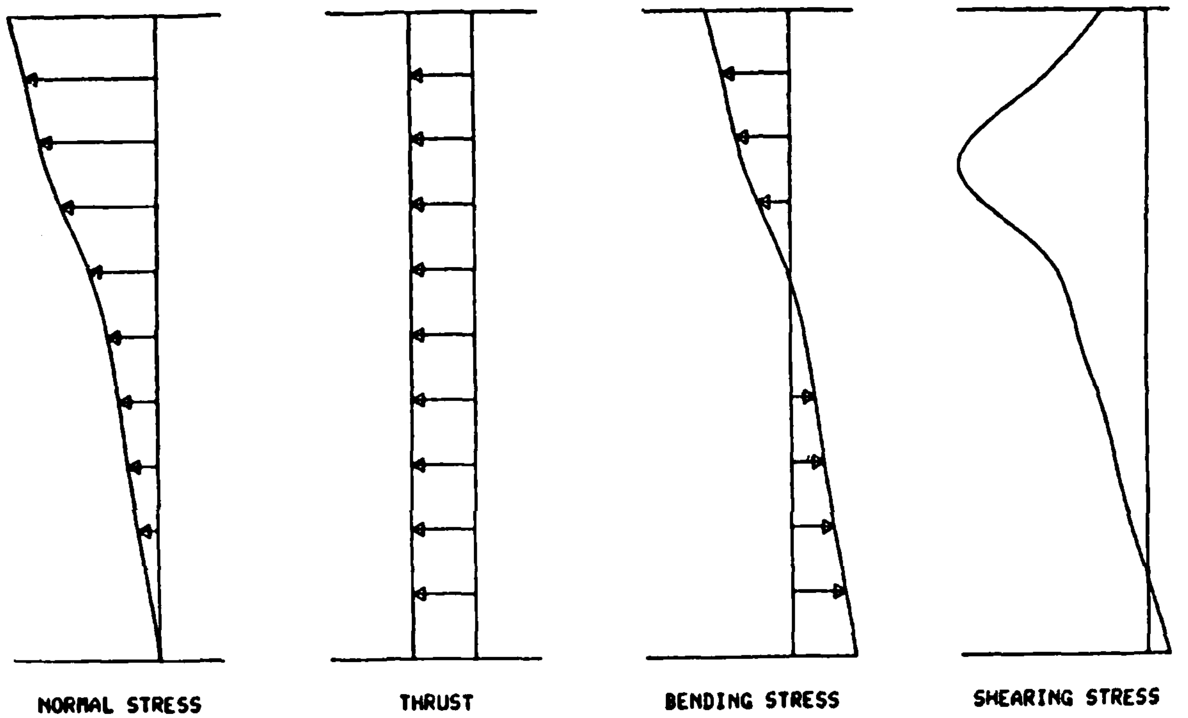
(X1. Y1) = (40 .14)
(X2. Y2) = (54 .14)
NEUTRAL AXIS = (46 62.14)
SHEAR = 3323
MOMENT = -2 17
THRUST = - 7351

Figure A80. Load case 5A (section 6A)



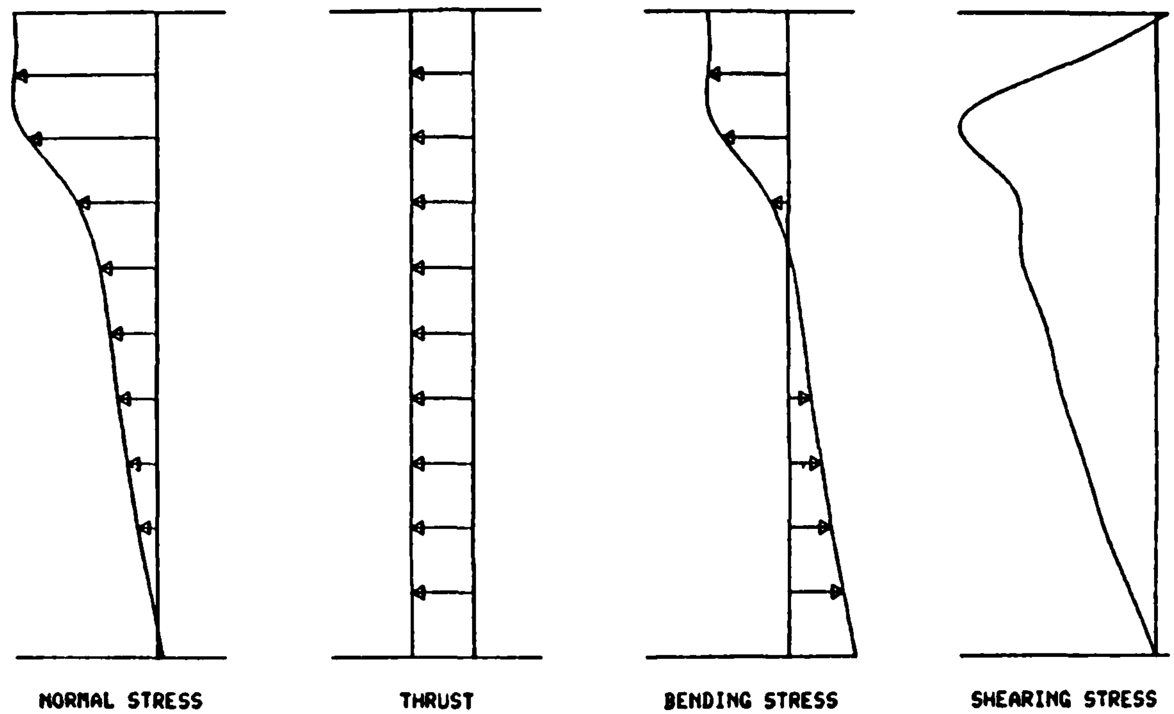
(X1, Y1) = (54 .1)
(X2, Y2) = (54 .11)
NEUTRAL AXIS = (54 .6 302)
SHEAR = .0702
MOMENT = .4234
THRUST = - 3593

Figure A81. Load case 5A (section 7A)



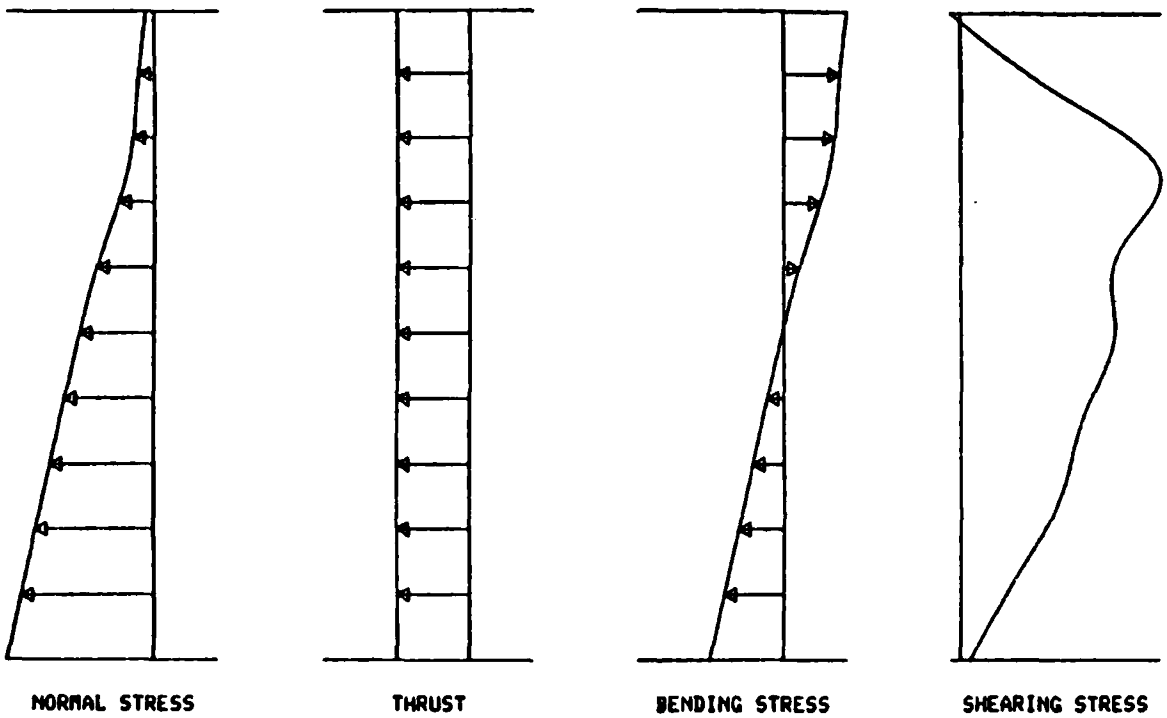
(X1, Y1) = (63 .3)
(X2, Y2) = (63 .11)
NEUTRAL AXIS = (63 .7 437)
SHEAR = - 0887
MOMENT = 3746
THRUST = - 3095

Figure A82. Load case 5A (section 8A)



(X1. Y1) • (40 .-1)
(X2. Y2) • (40 .13)
NEUTRAL AXIS • (40 .7 544)
SHEAR • - 5148
MOMENT • 1 972
THRUST • - 7591

Figure A83. Load case 5A (section 9A)



(X1, Y1) = (40 .36)
(X2, Y2) = (52 .36)
NEUTRAL AXIS = (46 6.36.)
SHEAR = 0474
MOMENT = - 391
THRUST = - 2505

Figure A84. Load case 5A (section 10A)

END

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